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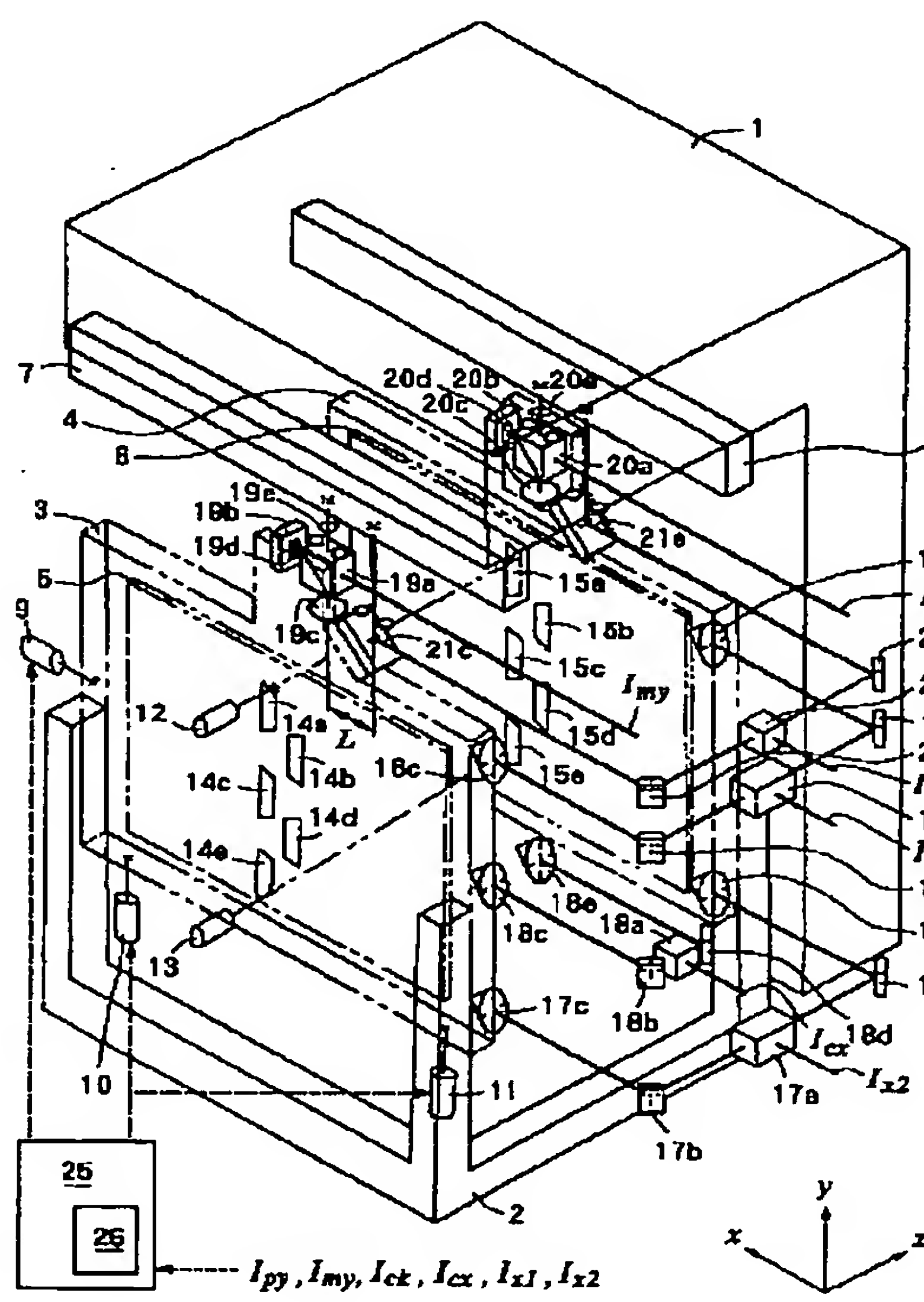
(54)【発明の名称】　走査型露光装置及び方法

(57)【要約】

【課題】長尺鏡の面精度によらずに、高精度に走査露光することができる走査型露光装置を提供する。

【解決手段】パターンが形成されたマスク５と、パターンの像を感光基板６に投影する投影光学系と、投影光学系に対してマスクと感光基板とを同期して投影光学系の光軸と直交する第１方向ｙに移動させる第１移動機構とを備えた走査型露光装置において、第１方向ｙに沿って固設され、マスク５と対向する反射面を有した第１の反射鏡７と、第１方向ｙに沿って固設され、感光基板６と対向する反射面を有した第２の反射鏡８と、第１移動機構による移動に応じて、マスクと第１の反射鏡との距離を検出する第１の干渉系I_{my}と、第１移動機構による移動に応じて、感光基板と第２の反射鏡との距離を検出する第２の干渉系I_{py}と、両干渉系I_{my}、I_{py}の検出結果に基づいて求められた、両反射面の平面度差に関するデータを記憶する記憶手段２６とを設けた。



【特許請求の範囲】

【請求項１】パターンが形成されたマスクと、前記マスクのパターンの像を感光基板に投影する投影光学系と、前記投影光学系に対して前記マスクと前記感光基板とを同期して前記投影光学系の光軸と直交する第１方向に移動させる第１移動機構とを備えた走査型露光装置において、
前記第１方向に沿って固設され、前記マスクの所定の端面と対向する反射面を有した第１の反射鏡と、
前記第１方向に沿って固設され、前記感光基板の所定の端面と対向する反射面を有した第２の反射鏡と、
前記第１移動機構による前記移動に応じて、前記マスクの所定の端面と前記第１の反射鏡との距離に関する量を検出する第１の干渉系と、
前記第１移動機構による前記移動に応じて、前記感光基板の所定の端面と前記第２の反射鏡との距離に関する量を検出する第２の干渉系と、
前記第１の干渉系と前記第２の干渉系との検出結果に基づいて求められた、前記第１の反射鏡の前記反射面と前記第２の反射鏡の前記反射面との平面度差に関するデータを記憶する記憶手段とを設けたことを特徴とする走査型露光装置。

【請求項２】請求項１記載の走査型露光装置において、
前記マスクと前記感光基板との少なくとも一方を前記投影光学系の光軸と前記第１方向とに直交する方向に移動する第２移動機構と、
前記第１移動機構による前記移動中に、前記記憶手段に記憶された前記データに基づいて前記第２移動機構を制御する制御手段とを設けたことを特徴とする走査型露光装置。

【請求項３】請求項１記載の走査型露光装置において、
前記平面度差に関するデータは、前記固設される前の前記第１の反射鏡の前記反射面と前記第２の反射鏡の前記反射面との平面度に関するデータにより補完されていることを特徴とする走査型露光装置。

【請求項４】マスクのパターンの像を投影光学系により感光基板に投影するとともに、前記投影光学系に対して前記マスクと前記感光基板とを同期して前記投影光学系の光軸と直交する第１方向に移動させて前記マスクのパターンの像を露光する走査型露光方法において、
前記マスクの所定の端面と対向する反射面を有し前記第１方向に沿って固設された第１の反射鏡と、前記マスクの所定の端面との距離に関する量を前記移動に応じて離散的に検出する第１ステップと、
前記感光基板の所定の端面と対向する反射面を有し前記第１方向に沿って固設された第２の反射鏡と、前記感光基板の所定の端面との距離に関する量を前記移動に応じて離散的に検出する第２のステップと、
前記第１、第２ステップの検出結果に基づいて、前記第１の反射鏡の前記反射面と前記第２の反射鏡の前記反射面との平面度差に関するデータを求めるステップとを含むことを特徴とする走査型露光方法。

【請求項５】請求項４記載の走査型露光方法において、
前記平面度差に関するデータを求めるステップは、前記固設される前の前記第１の反射鏡の前記反射面と前記第２の反射鏡の前記反射面との平面度に関するデータに基づいて求められることを特徴とする走査型露光方法。

【請求項６】請求項４または請求項５記載の走査型露光方法において、
前記露光中に前記平面度差に関するデータに応じて、前記マスクと前記感光基板との少なくとも一方を前記投影光学系の光軸と前記第１方向とに直交する方向に移動するステップを含むことを特徴とする走査型露光方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は走査型露光装置に関し、特に走査途中におけるマスクステージとプレートステージとの位置ずれの補正に関する。

【０００２】

【発明が解決しようとする課題】最近の液晶基板の大型化に対応するために、特願平８－１８４１１３号には、マスクの法線と走査方向との双方に直交する横方向についてのマスクとプレートとの間の相対的な位置ずれを計測するための基準となる、走査方向に延びた長尺鏡の面精度を厳しくすることなく、走査露光する技術が開示されている。しかし、この技術においては、長尺鏡に短い周期のうねりがある場合に、マスクとプレートとの間の横ずれを無視できるレベルに高精度に保つことが出来ないという不都合があった。本発明はこの問題点に鑑み、長尺鏡の面精度によらずに、高精度に走査露光することができる走査型露光装置とその手法を提供することを課題とする。

【０００３】

【課題を解決するための手段】本発明は上記課題を解決するためになされたものであり、一実施例を表す図１に対応付けて説明すると、パターンが形成されたマスク（５）と、前記マスクのパターンの像を感光基板（６）に投影する投影光学系と、前記投影光学系に対して前記マスクと前記感光基板とを同期して前記投影光学系の光軸と直交する第１方向に移動させる第１移動機構とを備えた走査型露光装置において、前記第１方向に沿って固設され、前記マスクの所定の端面と対向する反射面を有した第１の反射鏡（７）と、前記第１方向に沿って固設され、前記感光基板の所定の端面と対向する反射面を有した第２の反射鏡（８）と、前記第１移動機構による前記移動に応じて、前記マスクの所定の端面と前記第１の反射鏡との距離に関する量を検出する第１の干渉系（I_{my}、I_{ck}、I_{x1}、I_{x2}）と、前記第１移動機構による前記移動に応じて、前記感光基板の所定の端面と前記第２の反射鏡との距離に関する量を検出する第２の干渉系

（I_{py}、I_{ck}、I_{x1}、I_{x2}）と、前記第１の干渉系と前記第２の干渉系との検出結果に基づいて求められた、前記第１の反射鏡の前記反射面と前記第２の反射鏡の前記反射面との平面度差に関するデータを記憶する記憶手段（２６）とを設けたことを特徴とする走査型露光装置である。

【０００４】本発明はまた、マスク（５）のパターンの像を投影光学系により感光基板（６）に投影するとともに、前記投影光学系に対して前記マスクと前記感光基板とを同期して前記投影光学系の光軸と直交する第１方向に移動させて前記マスクのパターンの像を露光する走査型露光方法において、前記マスクの所定の端面と対向する反射面を有し前記第１方向に沿って固設された第１の反射鏡（７）と、前記マスクの所定の端面との距離に関する量を前記移動に応じて検出する第１ステップと、前記感光基板の所定の端面と対向する反射面を有し前記第１方向に沿って固設された第２の反射鏡（８）と、前記感光基板の所定の端面との距離に関する量を前記移動に応じて検出する第２のステップと、前記第１、第２ステップの検出結果に基づいて、前記第１の反射鏡の前記反射面と前記第２の反射鏡の前記反射面との平面度差に関するデータを求めるステップとを含むことを特徴とする走査型露光方法である。

【０００５】

【発明の実施の形態】本発明の実施の形態を図面を用いて説明する。図１に本発明による走査型露光装置の一実施例の概略構成を示す。以下の説明では、走査方向、すなわち縦方向をｘ軸とし、マスク５と同一面内においてｘ軸に直交する横方向をｙ軸とし、マスク５の法線方向をｚ軸とする座標系をとっている。超高圧水銀ランプ等の光源（不図示）から射出された照明光は、光ファイバー等（不図示）を介して、５つ照明光学系（不図示）に導かれる。各照明光学系は、それぞれフライアイレンズ、視野絞り等（不図示）を含んで構成される。各照明光学系から射出されたそれぞれの照明光は、マスク５上の異なる照明領域１４ａ～１４ｅを均一に照明する。マスク５を通過した各光束は、それぞれ等倍正立の結像を行う５つの投影レンズ部を有した投影光学系ＰＬ（図９参照）を介して、感光基板であるプレート６上の異なる露光領域１５ａ～１５ｅを露光し、こうしてマスク５上の照明領域１４ａ～１４ｅのパターンの像をプレート６上に結像する。各照明領域１４ａ～１４ｅはそれぞれ分離して配置されているが、各照明領域１４ａ～１４ｅのｘ方向の幅をｘ方向に積算した積算幅は、同一の幅を持ってｙ方向に連続するように形成されている。

【０００６】各照明光学系と各投影光学系は、架台１によって支持されている。架台１には、駆動装置（不図示）によってｘ方向に走行駆動されるキャリッジ２が搭載されており、このキャリッジ２に、マスクステージ３とプレートステージ４とが保持されている。マスクステージ３にはマスク５が保持されており、プレートステージ４にはプレート６が保持されており、こうしてキャリッジ２をｘ方向に走査することにより、マスク５上のパターンの全体がプレート６上に転写される。マスクステージ３は、微動機９～１１を介してキャリッジ２に支持されており、すなわちｘ方向微動機９によってマスクステージ３のｘ方向の位置を微動し、ｙ方向微動機１０，１１によってマスクステージ３のｙ方向の位置とｚ軸回りの回転方向とを微動できるように構成されている。

【０００７】一方、プレートステージ４は、プレート６の厚みムラや傾きの影響を補正し、同時にマスクパターンの結像面に一致させるために、３つ以上のｚ方向微動機（不図示）を介してキャリッジ２に支持されており、こうしてｚ方向の微動（オートフォーカス）と、ｘ軸回り及びｙ軸回りの傾斜角度（オートレベリング）を調節できるように構成されている。また架台１には、マスク用長尺鏡７とプレート用長尺鏡８が固定されている。両長尺鏡７，８はｘ方向に長く延びた反射鏡であり、その反射面の法線はｙ方向を向いている。マスク用長尺鏡７はマスクステージ３に対向して配置され、プレート用長尺鏡８はプレートステージ４に対向して配置されている。

【０００８】図９は、図１の走査型露光装置を部分的に表わした斜視図である。投影光学系ＰＬは、照明領域１４ａ～１４ｅのそれぞれの領域を通過した光束をプレート６に投影するため千鳥状に配置された５つの投影レンズ部を有している。なお、図９では５つの投影レンズ部を代表して投影光学系ＰＬと表わしており、また、投影光学系ＰＬの光軸をＡＸと示している。図９から明らかなように、マスク用長尺鏡７とプレート用長尺鏡８とは、投影光学系ＰＬの光軸ＡＸと直交する第１の方向であるＸ方向に沿って配設されている。

【０００９】図１に戻ってマスクステージ３とプレートステージ４の位置と姿勢は、次のように６つの干渉計I_{x1}、I_{x2}、I_{cx}、I_{my}、I_{py}及びI_{ck}によって監視されている。先ず差動型干渉計I_{x1}は、マスクステージ３とプレートステージ４とのｘ方向の相対的な位置ずれ（縦ずれ）を計測するためのものである。すなわち架台１に固定されたレーザー光源（不図示）から射出されたレーザー光束は、架台１に固定されたビームスプリッタ１６ａにより分割され、分割された各光束は、それぞれ架台１に固定された反射鏡１６ｂ，１６ｄで反射し、それぞれマスクステージ３とプレートステージ４とに固定され反射鏡１６ｃ，１６ｅで反射し、往路を逆進してビームスプリッタ１６ａで合成されて干渉し、干渉計I_{x1}のレシーバ（不図示）に入射する。

【００１０】差動型干渉計I_{x2}は、干渉計I_{x1}とはｙ方向に異なる位置において、マスクステージ３とプレートステージ４とのｘ方向の相対的な位置ずれ（縦ずれ）を計測するためのものである。すなわち干渉計I_{x2}用のレ

ーザー光束は、ビームスプリッタ１７ａにより分割され、分割された各光束は、それぞれ反射鏡１７ｂ，１７ｄで反射し、それぞれマスクステージ３とプレートステージ４とに固定され反射鏡１７ｃ，１７ｅで反射し、往路を逆進してビームスプリッタ１７ａで合成され、干渉計I_{x2}のレシーバに入射する。なお、マスクステージ３に固定した反射鏡１６ｃと１７ｃとの間隔と、プレートステージ４に固定した反射鏡１６ｅと１７ｅとの間隔は等しく、以降この間隔をＨとする。マスクステージ３上の反射鏡１６ｃ、１７ｃ及びプレートステージ４上の反射鏡１６ｅ、１７ｅの位置は、各ステージ３，４の中心から等距離にあることが望ましい。

【００１１】測長型干渉計I_{cx}は、キャリッジ２の移動距離を計測するためのものである。すなわち干渉計I_{cx}用のレーザー光束は、ビームスプリッタ１８ａにより分割され、分割された各光束は、それぞれ架台１に固定された反射鏡１８ｂ，１８ｄで反射し、一方の光束はマスクステージ３上に固定された反射鏡１８ｃで反射し、他方の光束は投影光学系に固定された固定鏡１８ｅで反射し、両光束は往路を逆進してビームスプリッタ１８ａで合成されて干渉し、干渉計I_{cx}のレシーバに入射する。こうして干渉計I_{cx}によって、マスクステージ３と固定鏡１８ｅとのｘ方向の距離が計測される。

【００１２】測長型干渉計I_{my}は、マスクステージ３とマスク用長尺鏡７とのｙ方向の距離を計測するためのものである。また測長型干渉計I_{py}は、プレートステージ４とプレート用長尺鏡８とのｙ方向の距離を計測するためのものである。両干渉計I_{my}，I_{py}は同様の構成であるので、干渉計I_{my}についての説明をかっこ外に記載し、干渉計I_{py}についての説明をかっこ内に記載する。すなわち干渉系I_{my}（I_{py}）用のレーザ光束はマスクステージ３（プレートステージ４）に固定されたビームスプリッタ１９ａ（２０ａ）により２つの光束に分割される。この２つの光束の内のビームスプリッタ１９ａ（２０ａ）を透過した光束は、マスクステージ３（プレートステージ４）上に配設されたλ／４板１９ｄ（２０ｄ）を通り、マスクステージ３（プレートステージ４）上に配設された反射鏡１９ｂ（２０ｂ）で反射し、再びλ／４板１９ｄ（２０ｄ）を通る。λ／４板１９ｄ（２０ｄ）を通った光束は、ビームスプリッタ１９ａ（２０ａ）と、マスクステージ３（プレートステージ４）上に配設されたコーナキューブ１９ｃ（２０ｃ）と、ビームスプリッタ１９ａ（２０ａ）とをそれぞれ反射してλ／４板１９ｄ（２０ｄ）を通り反射鏡１９ｂ（２０ｂ）で反射し、λ／４板１９ｄ（２０ｄ）、ビームスプリッタ１９ａ（２０ａ）をそれぞれ通り干渉系I_{my}（I_{py}）のレシーバに入射する。

【００１３】ビームスプリッタ１９ａ（２０ａ）により分割された光束の内のビームスプリッタ１９ａ（２０ａ）で上方に反射された光束は、λ／４板１９ｅ（２０ｅ）を通り長尺鏡７（８）で反射し、λ／４板１９ｅ（２０ｅ）とビームスプリッタ１９ａ（２０ａ）とをそれぞれ通りコーナキューブ１９ｃ（２０ｃ）で反射する。コーナキューブ１９ｃ（２０ｃ）で反射された光束は、ビームスプリッタ１９ａ（２０ａ）とλ／４板１９ｅ（２０ｅ）とをそれぞれ通り、長尺鏡７（８）で反射して、λ／４板１９ｅ（２０ｅ）を通りビームスプリッタ１９ａ（２０ａ）で反射されて干渉系I_{my}（I_{py}）のレシーバに入射する。これにより、ビームスプリッタ１９ａ（２０ａ）により２つの光束に分割された光束は、再びビームスプリッタ１９ａ（２０ａ）で合成されて干渉してレシーバに入射する。

【００１４】差動型干渉計I_{ck}は、両長尺鏡７，８を介して、マスクステージ３とプレートステージ４とのｙ方向の相対的な位置ずれを計測するためのものである。すなわち干渉計I_{ck}用のレーザー光束は、ビームスプリッタ２１ａにより分割され、分割された各光束は、それぞれ架台１に固定された反射鏡２１ｂ，２１ｄで反射し、一方の光束はマスクステージ３上の反射鏡２１ｃで反射し、マスク用長尺鏡７で反射する。他方の光束はプレートステージ４上の反射鏡２１ｅで反射し、プレート用長尺鏡８で反射する。両光束は往路を逆進してビームスプリッタ２１ａで合成されて干渉し、干渉計I_{ck}のレシーバに入射する。なお、マスクステージ３に固定したコーナキューブ１９ｃと反射鏡２１ｃとのｘ方向の間隔と、プレートステージ４に固定したコーナキューブ２０ｃと反射鏡２１ｅとのｘ方向の間隔は等しく、以降この間隔をＬとする。

【００１５】キャリッジ２の位置をｘとし、マスクステージ３とプレートステージ４とのｘ方向の相対的な位置ずれ量（縦ずれ量）をΔＸ（ｘ）とし、ｙ方向の相対的な位置ずれ量（横ずれ量）をΔＹ（ｘ）とし、ｚ軸回りの相対的な角度ずれ量をΔＴ（ｘ）とする。また両長尺鏡７，８の平面度差をΔｈ（ｘ）とする。平面度差Δｈとは、マスク用長尺鏡７の反射面とプレート用長尺鏡８の反射面とのｙ方向の相対的な位置ずれ量（横ずれ量）である。各干渉計I_{x1}、I_{x2}、I_{cx}、I_{my}、I_{py}、I_{ck}の計測値をそれぞれ同じ文字を用いて、I_{x1}、I_{x2}、I_{cx}、I_{my}、I_{py}、I_{ck}と表すと、

$$\Delta X(x) = (I_{x1} + I_{x2}) / 2 \quad \cdots\cdots (1)$$

$$\Delta T(x) = (I_{x1} - I_{x2}) / H \quad \cdots\cdots (2)$$

$$\Delta Y(x) = I_{my} - I_{py} - \Delta h(x) \quad \cdots\cdots (3)$$

となる。

【００１６】上記（１）～（３）式のうち、（１）式の縦ずれΔＸと（２）式の角度ずれΔＴの値は、干渉計I_{x1}，I_{x2}の計測値から直ちに得られる。また（３）式の横ずれΔＹについては、平面度差Δｈがキャリッジ２の位置ｘの関数として、制御装置２５内の記憶装置２６内に格納されており、このΔｈ（ｘ）と干渉計I_{my}，I_{py}の計測値とから、横ずれΔＹを求めている。こうしてｘ

－ｙ面内での縦ずれΔＸと横ずれΔＹと角度ずれΔＴに対して、制御装置２５によって微動機９～１１を駆動し、マスクステージ３の位置をｘ－ｙ面内で微調整することにより、走査露光時のマスクステージ３とプレートステージ４との相対的な位置関係を一定に保っている。

【００１７】以下に、両長尺鏡７，８の平面度差Δｈ（ｘ）の求め方について説明する。この平面度差Δｈ（ｘ）は、各長尺鏡７，８自体の鏡面形状と、各長尺鏡７，８の架台１への取り付け姿勢に依存する。本実施例は、一方において各長尺鏡７，８自体の鏡面形状を連続的に測定し、他方において各長尺鏡７，８を架台１に取り付けたときの平面度差Δｈ（ｘ）を離散的に測定し、しかる後に離散的に求められた平面度差Δｈの各区間内を、両長尺鏡７，８の連続的な形状の差で補間することにより、平面度差Δｈをｘの連続関数として求めるものである。

【００１８】そこで先ず、各長尺鏡７，８自体の鏡面形状を連続的に求める方法について説明する。図２は各長尺鏡７，８の面精度を連続的に計測するための概要を示した図である。この計測は架台１への組み込み前、例えば、長尺鏡７，８の研磨終了時に、面精度の確認と計測を兼ねて行うのが効率的である。また計測時の長尺鏡７，８の姿勢は、架台１に組み込んだときの姿勢と同一とすることが望ましい。

【００１９】レーザー光源３０から射出されたレーザー光束は、ビームエキスパンダ３１により光径を広げられ、レンズ３２を通り平行光線となる。次いでレーザー光はハーフミラー３３を透過し、透過光の一部はフィゾー素子の最終面に設けた参照面３５で反射し、往路を逆進してハーフミラー３３に戻る。参照面３５の裏面３４には反射防止膜がコーティングされている。他方、参照面３５を透過したレーザー光は、マスク用長尺鏡７（又はプレート用長尺鏡８）で反射し、往路を逆進してハーフミラー３３に戻る。参照面３５で反射したレーザー光と長尺鏡７（８）で反射したレーザー光は干渉し、ハーフミラー３３で反射し、検出器３６に達する。こうして検出器３６によって参照面３５に対する長尺鏡７（８）の面精度を計測することができ、すなわち長尺鏡７（８）の任意の点における平面度を求めることが可能となる。

【００２０】なお液晶基板の大型化に伴い、長尺鏡７（８）は長くなることが予想されるが、参照面３５よりも長くなった場合には、長尺鏡７（８）をずらして複数回の測定を行うことにより、全面を計測することができる。ただし、この場合、後述する干渉計I_{my}、I_{py}、I_{ck}による計測点をオーバーラップさせて計測する必要がある。また図２では長尺鏡７（８）の面精度の計測にフィゾー干渉計を用いているが、計測方法はこれに限られたものではない。

【００２１】次に長尺鏡の平面度差を離散的に計測する方法について説明する。計測はキャリッジ２を走査しながら、一定の計測間隔Ｌごとに計測する。計測終了までは、マスクステージ３とプレートステージ４は相対的に固定し、すなわち微動機９～１１は駆動しない。計測を行う間隔Ｌは、干渉計I_{my}又は干渉計I_{py}の光束が長尺鏡７又は長尺鏡８で反射する位置と、干渉計I_{ck}の光束が長尺鏡７又は長尺鏡８で反射する位置とのｘ方向の間隔とする。計測は次のように行う。長尺鏡７，８の一端にキャリッジ２を移動したときの干渉計I_{my}、I_{py}、I_{ck}の値を計測する。次いでキャリッジ２の位置を干渉計I_{cx}で計測しながら、キャリッジ２の位置をＬだけ移動し、その位置で干渉計I_{my}、I_{py}、I_{ck}の値を計測する。以下同様に、キャリッジ２の位置をＬだけ移動するごとに、干渉計I_{my}、I_{py}、I_{ck}の値を計測する。

【００２２】以下簡単のために、長尺鏡上の離散的な計測位置ｉにおける干渉計I_{my}、I_{py}、I_{ck}の計測値をそれぞれ$I_{my}(i)$、$I_{py}(i)$、$I_{ck}(i)$と標記する。すなわち離散的な位置を意味するときには変数ｉを使用し、連続的な位置を意味するときには変数ｘを使用する。なお明らかに、同一のキャリッジ２の位置において計測されるのは、$I_{my}(i)$、$I_{py}(i)$、$I_{ck}(i-1)$である。また、計測開始位置での干渉計の値を$I_{my}(1)$、$I_{py}(1)$、$I_{ck}(0)$とする。

【００２３】干渉計I_{my}は、マスクステージ３とマスク用長尺鏡７とのｙ方向の距離を計測しており、干渉計I_{py}は、プレートステージ４とプレート用長尺鏡８とのｙ方向の距離を計測している。したがってこれらの両干渉計I_{my}，I_{py}の計測値には、両長尺鏡７，８の平面度差Δｈ以外に、キャリッジ２のローリング誤差（ｘ軸回りの回転）と、干渉計リセット時のオフセットが含まれる。計測位置ｉにおける両長尺鏡の平面度差をΔｈ（ｉ）とし、ローリング量をｒ（ｉ）とし、両干渉計I_{my}，I_{py}のリセット時のオフセットをそれぞれＡ，Ｂとする。

【００２４】両干渉計I_{my}，I_{py}の計測値の差として$I_y(i)$を新たに、

$$I_y(i) \equiv I_{my}(i) - I_{py}(i) \quad \cdots\cdots (4)$$

と定義すると、次式が成り立つ。

$$I_y(i) \equiv I_{my}(i) - I_{py}(i) = \Delta h(i) + r(i) + A - B \quad \cdots\cdots (5)$$

（５）式中、$I_y(i)$は測定値であり、右辺は未知である。

【００２５】また干渉計I_{ck}は、両長尺鏡７，８を介して、マスクステージ３とプレートステージ４とのｙ方向の位置ずれを計測している。したがって干渉計I_{ck}の計測値には、両長尺鏡７，８の平面度差Δｈと、キャリッジ２のローリングに起因する誤差ｒと、干渉計リセット時のオフセットＣのほかに、更に、マスクステージ３とプレートステージ４との縦ずれΔＸと、ｚ軸回りの角度ずれΔＴに起因する位置ずれが含まれる。また同時に計

測された干渉計I_{my}、I_{py}、I_{ck}の計測値に含まれるローリング量は等しい。したがってI_{ck}（ｉ－１）は次式

$$I_{ck}(i-1)=\Delta h(i-1)+r(i)+C+\Delta X(i-1)+\Delta T(i-1)\cdot H \quad \cdots\cdots(6)$$

で表される。

【００２６】縦ずれΔＸと角度ずれΔＴは測定値であるから、I_{ck}'を（７）式で定義すると、（６）式は

$$I_{ck}'(i)\equiv I_{ck}(i)-\Delta X(i)-\Delta T(i)\cdot H \quad \cdots\cdots(7)$$

$$I_{ck}'(i-1)=\Delta h(i-1)+r(i)+C \quad \cdots\cdots(8)$$

（８）式となる。

（８）式中、I_{ck}'（ｉ－１）は測定値であり、右辺は未知である。

【００２７】更に、キャリッジ２のローリングに起因する誤差ｒを消去するために、ΔＨを（９）式で定義すると、ΔＨは（５）式と（８）式から（１０）式のようになる。

$$\Delta H(i)\equiv I_{y}(i)-I_{ck}'(i-1) \quad \cdots\cdots(9)$$

$$\Delta H(i)=\Delta h(i)-\Delta h(i-1)+A-B-C \quad \cdots\cdots(10)$$

（１０）式中、ΔＨ（ｉ）は干渉計I_{my}、I_{py}、I_{ck}、I_{x1}、I_{x2}の計測値から求められ、右辺は未知である。

【００２８】ΔＨ（ｉ）のｉ＝１からｉ＝ｋ（ｋ≧１）までの和をＳ（ｋ）とし、長尺鏡の位置ｋを新たに位置ｉと標記すると、

$$S(i)\equiv\Delta H(1)+\Delta H(2)+\cdots+\Delta H(i) \quad \cdots\cdots(11a)$$

$$\begin{aligned}S(i)&=\Delta h(1)-\Delta h(0)+A-B-C\\&\quad+\Delta h(2)-\Delta h(1)+A-B-C\\&\quad+\cdots+\\&\quad+\Delta h(i)-\Delta h(i-1)+A-B-C\\&=\Delta h(i)-\Delta h(0)+(A-B-C)\times i \quad (i\geqq 1)\end{aligned} \quad \cdots\cdots(11b)$$

となる。（１１ｂ）式中、Ｓ（ｉ）は測定値であり、右辺は未知である。かくして（１１ｂ）式より、位置ｉにおける長尺鏡の平面度差Δｈ（ｉ）は、

$$\Delta h(i)=S(i)+\Delta h(0)-(A-B-C)\times i \quad (i\geqq 1) \quad \cdots\cdots(12)$$

となる。ｉ＝０のときＳ（０）≡０とおくと、ｉ＝０のときも（１２）式が成り立つ。

【００２９】（１２）式の右辺中、Ｓ（ｉ）は測定値であり、Δｈ（０）と（Ａ－Ｂ－Ｃ）×ｉが未知数である。このうち、Δｈ（０）は長尺鏡の計測位置ｉに拘らず常に一定のオフセットであるから、（３）式より明らかなように、マスクステージ３とプレートステージ４との間の横ずれ量ΔＹ（ｘ）は変化せず、すなわちマスクステージ３とプレートステージ４とのアライメントをすることにより誤差とならない。一方、（Ａ－Ｂ－Ｃ）×ｉは長尺鏡の位置ｉに依存して線形に変化するから、その係数（Ａ－Ｂ－Ｃ）を求める必要がある。そこで次に係数（Ａ－Ｂ－Ｃ）の求め方を示す。

【００３０】先ず第１工程として、（１２）式中のＳ（ｉ）を測定するために、キャリッジ２を走査して各干渉計の計測値を測定する。このとき既述のごとく、マスクステージ３とプレートステージ４との間の縦ずれ量ΔＸは（１）式によって連続的に計測され、ｘ－ｙ面内での角度ずれ量ΔＴは（２）式によって連続的に計測されるから、これらのずれ量ΔＸ，ΔＴを一定に保ちながら、キャリッジ２を走査することができる。しかし横ずれ量ΔＹは、平面度差Δｈ（ｘ）が未知であるのみならず、その離散値Δｈ（ｉ）も未知であるから、横ずれ量ΔＹを一定に保つことはできない。そこで先ず、横ずれの調整は全く行わずにキャリッジ２を走査し、そのときのｘ＝０，Ｌ，２×Ｌ，・・・・，ｉ×Ｌ，・・・・での干渉計I_{my}、I_{py}の計測値I_{my}（ｉ）、I_{py}（ｉ）を測定する。次いで第２工程として、（１１ａ）式によってＳ（ｉ）を求める。

【００３１】次いで第３工程として、（１２）式中の（Ａ－Ｂ－Ｃ）を求めるために、図３に示す誤差計測用のマスク４０をマスクステージ３にセットし、誤差計測用のプレートをプレートステージ４にセットして、１回目の走査露光を行う。但し、（１２）式中のＳ（ｉ）は既知となったが、係数（Ａ－Ｂ－Ｃ）は未知であるために、この係数（Ａ－Ｂ－Ｃ）を無視し、すなわち両長尺鏡の平面度差の暫定式として、

$$\Delta h(i)=S(i) \quad \cdots\cdots(13)$$

を用いる。また、ｉは離散値であるからΔｈ（ｉ）とΔｈ（ｉ＋１）の間を、１次式で補間する。すなわち計測位置ｉと干渉計I_{cx}で計測されるキャリッジ２の位置ｘとの関係は、計測開始位置における干渉計I_{cx}の値を０とすると、次式で表される。

$$x=i\times L \quad \cdots\cdots(14)$$

【００３２】したがって、キャリッジ２が長尺鏡上の計測位置ｉとｉ＋１との間にあるときの両長尺鏡の平面度

差の暫定式Δｈ（ｘ）は、次式で表される。

$$\Delta h(x) = [\Delta h(i+1) - \Delta h(i)] \times (x/L - i) + \Delta h(i) \quad \cdots\cdots (15)$$

かくして（１３）式と（１５）式によって両長尺鏡の平面度差の暫定値が連続的に得られるから、（３）式によってマスクステージ３とプレートステージ４との間の横ずれ量ΔＹを求め、この横ずれ量ΔＹを一定に保ちながらキャリッジ２を走査する。

【００３３】図３は誤差計測用のマスク４０を示し、このマスク４０にはｘ方向に１列に、またｙ方向には間隔Ｌごとに、複数のマーク４１が描画されている。マーク４１のｙ方向の間隔は、両長尺鏡の離散的平面度計測における計測間隔Ｌと一致させることが好ましい。図４は１つのマーク４１の拡大図を示しており、露光位置検出用のパターンである。同図において斜線部は遮光領域であり、十文字状の部分が透光領域である。ここでは露光位置検出用に十字マークを用いたが、露光位置が検出できるマークであればどのようなマークでもかまわない。また、誤差検出用マスク４０には、一対のマスク用アライメントマーク４２，４３と、一対のプレート用アライメントマーク４４，４５が描画されている。両マーク４２，４３；４４，４５は、図３に示すように、ｘ方向とｙ方向との双方に若干ずらして配置されている。

【００３４】マスク４０の走査露光の後に、プレートを現像する。プレート４８には、図５に示すように、複数のマーク４１の転写マーク４９のほかに、マスク用アライメントマーク４２，４３の転写マーク（不図示）と、プレート用アライメントマーク４４，４５の転写マーク４６，４７が転写される。次いでマスク４０とプレートを共に９０度回転させて、それぞれマスクステージ３とプレートステージ４にセットし、マスク４０上のマスク用アライメントマーク４２，４３と、プレート４８上のプレート用アライメントマーク転写マーク４６，４７とのアライメントを行う。すなわち両マーク４２，４３；４６，４７の相対的な位置誤差をアライメント顕微鏡１２、１３により計測し、微動機９～１１を駆動して、両マーク４２，４３；４６，４７の位置を合わせ、しかる後に２回目の露光を行う。

【００３５】マスク４０上のマスク用アライメントマーク４２，４３と、プレート用アライメントマーク４４，４５とは、ｘ，ｙ方向に若干ずれて配置されており、２回目の露光時には、マスク用アライメントマーク４２，４３と、プレート用アライメントマークの転写マークとを位置合わせした。したがって１回目の露光と２回目の露光との間では、マスク用アライメントマーク４２，４３とプレート用アライメントマーク４４，４５との間隔だけ、マスク４０とプレート４８とをずらして露光したことになる。

【００３６】この結果、２回の露光によって得られる複数のマーク４１の像４９は、図６に示すように、十字マークが２つある像となる。両方の十字マークの間隔を顕微鏡等で計測し、この測定値から、マスク４０とプレート４８との位置ずれ量を差し引くことにより、両方の十字マークの間の正味のずれ量を知ることができる。ここで微動機９～１１の制御は、ｘ方向には正確に制御しており、ｙ方向には暫定式によって制御している。したがってマーク４１とその像との間には、ｘ方向にはずれがなく、ｙ方向には暫定式によって制御したことによる誤差だけ位置ずれを生じる。すなわち１回目の露光において、マーク４１とその像との間にはｘ方向にずれはなく、２回目の露光時には９０度回転していたから、２回目の露光時の配置についていえば、マーク４１とその１回目の像との間には、ｙ方向にずれがない。また、２回目の露光時の配置について、マーク４１とその２回目の像との間には、ｙ方向に暫定式によって制御したことによる誤差だけ位置ずれを生じる。したがって両方の十字マークの間のｙ方向の正味のずれ量を計測することにより、暫定式によって制御したことによる誤差を知ることができる。

【００３７】次いで第４工程として、係数（Ａ－Ｂ－Ｃ）を求める。図７は横軸にマーク４１の位置ｉを取り、縦軸にｙ方向、すなわち横方向の正味の位置ずれ量をプロットした図である。横方向の正味の位置ずれ量は、

$$-\Delta h(0) + (A-B-C) \times i \quad \cdots\cdots (16)$$

となるから、図７のプロットした点から回帰直線５０を求めると、その勾配が係数（Ａ－Ｂ－Ｃ）となる。かくして（１２）式より、両長尺鏡の離散的な平面度差Δｈ（ｉ）を求めることができる。

【００３８】なお、第３工程における微動機の制御は、Ｓ（ｉ）を測定した各計測点においては、（Ａ－Ｂ－Ｃ）×ｉを無視している点を除いて正しい制御が行われている。したがって正味の横ずれ量を測定する計測点は、Ｓ（ｉ）を求めたときの計測点と一致させることが好ましい。なぜならば、Ｓ（ｉ）を求めたときの計測点以外の点で正味の横ずれ量を測定すると、（Ａ－Ｂ－Ｃ）×ｉ以外の要素が加わるおそれがあるからである。正味の横ずれ量を測定する計測点と、Ｓ（ｉ）を求めたときの計測点とを一致させるためには、先ずマーク４１の間隔を、Ｓ（ｉ）を求めたときの計測間隔Ｌと一致させる必要がある。次いで計測点自体を一致させるために、キャリッジ２の走査方向の基準位置を決める際に、２回目の露光の配置でマスク４０をセットし、マスク４０上のマーク４１が露光位置に一致するところから、Ｌの整数倍でキャリッジを移動したところを基準位置とすれば良い。なお当然に、１回目の露光と２回目の露光との順序を逆転しても良い。

【００３９】またこのように正味の横ずれ量を測定する計測点と、Ｓ（ｉ）を求めたときの計測点とを一致させたときには、各計測点の中間位置での微動機の制御は、特に問題とならない。したがって本実施例では各計測点の間を単に線形に補間したが、例えば、各計測点の間を、両長尺鏡の実際の平面度差によって補間することもできる。このように各計測点の間を、両長尺鏡の実際の平面度差によって補間する手法は、正味の横ずれ量を測定する計測点と、Ｓ（ｉ）を求めたときの計測点とを一致させることが困難なときに、有効である。

【００４０】また、２回の露光によってｙ方向の位置ずれを離散的に計測する方法に代えて、露光を行わずに、次のようにしてｙ方向の位置ずれを離散的に計測することもできる。すなわち図８（ａ）と（ｂ）に示すように、誤差計測用のマスク６０とプレート６１のｙ方向の一端側に、それぞれ複数のアライメントマーク６２とアライメントマーク６３を間隔Ｌでｘ方向に配置し、ｙ方向の他端側に、それぞれアライメントマーク６２ｂとアライメントマーク６３ｂを配置する。このマスク６０とプレート６１をそれぞれマスクステージとプレートステージにセットし、マスク６０上の複数のアライメントマーク６２のうちの１つのアライメントマーク６２ａと、プレート６１上の複数のアライメントマーク６３のうちの１つのアライメントマーク６３ａをアライメントし、マスク６０上のアライメントマーク６２ｂと、プレート６１上のアライメントマーク６３ｂをアライメントすることにより、マスク６０とプレート６１の位置決めを行う。

【００４１】次いで縦ずれ量ΔＸは（１）式によって正確に制御し、ｘ－ｙ面内での角度ずれ量ΔＴは（２）式によって正確に制御し、横ずれ量ΔＹは、（１３）式と（１５）式によって得られる両長尺鏡の平面度差の暫定式を用いて（３）式によって制御しながら、キャリッジ２を走査する。そしてマスク６０上の複数のアライメントマーク６２と、プレート６１上の複数のアライメントマーク６３とのｙ方向の誤差をアライメント顕微鏡１２を用いて計測する。その際、計測終了までは、アライメント顕微鏡１２により計測された誤差は補正しない。しかる後、横軸にアライメントマーク６２，６３の位置を取り、縦軸にｙ方向の計測誤差をプロットすれば、図７と同様な結果が得られるから、両長尺鏡の離散的な平面度差Δｈ（ｉ）を求めることができる。

【００４２】次に第５工程として、両長尺鏡の離散的な平面度差Δｈ（ｉ）と、干渉計で計測した各長尺鏡７，８自体の鏡面形状とを合成することにより、任意の位置における長尺鏡の平面度差Δｈ（ｘ）を求める。干渉計で計測したマスク側長尺鏡７の平面度を$k_m(x)$とし、プレート側長尺鏡８の平面度を$k_p(x)$とすると、干渉計で計測した姿勢における両長尺鏡の平面度差Δｋ（ｘ）は、

$$\Delta k(x) = k_m(x) - k_p(x)$$

となる。

【００４３】両長尺鏡の離散的な平面度差Δｈ（ｉ）と、干渉計で計測した姿勢における両長尺鏡の平面度差Δｋ（ｘ）との合成は、各区間［ｉ，ｉ＋１］ごとにΔｋ（ｘ）を区切り、その区間の両端でΔｈ（ｉ）とΔｈ（ｉ＋１）とに一致するように、Δｋ（ｘ）をｙ方向に移動し、且つｙ方向に拡大又は縮小することによって行う。すなわち各区間ごとにΔｋ（ｘ）に加算する移動量をsft（ｉ）とし、各区間ごとに加算する勾配をmag（ｉ）とすると、

$$\Delta h(i) = \Delta k(x) + \mathrm{sft}(i) + \mathrm{mag}(i) \times (x - i \times L) \quad [i \times L \leqq x \leqq (i+1) \times L] \quad \cdots\cdots (17)$$

となる。

【００４４】ｘ＝ｉ×Ｌにおいて、

$$\Delta h(i) = \Delta k(i \times L) + \mathrm{sft}(i) \quad \cdots\cdots (18)$$

であり、ｘ＝（ｉ＋１）×Ｌにおいて、

$$\Delta h(i+1) = \Delta k((i+1) \times L) + \mathrm{sft}(i) + \mathrm{mag}(i) \times L \quad \cdots\cdots (19)$$

であるから、

$$\mathrm{sft}(i) = \Delta h(i) - \Delta k(i \times L) \quad \cdots\cdots (20)$$

$$\mathrm{mag}(i) = [\Delta h(i+1) - \Delta k((i+1) \times L) - \Delta h(i) + \Delta k(i \times L)] / L \quad \cdots\cdots (21)$$

となる。

【００４５】したがって、区間ｉ×Ｌ≦ｘ≦（ｉ＋１）×Ｌにおける長尺鏡の連続的な平面度差Δｈ（ｘ）は、

$$\Delta h(x) = \Delta k(x) + \mathrm{sft}(i) + \mathrm{mag}(i) \times (x - i \times L) \quad \cdots\cdots (22)$$

となる。ただし、sft（ｉ）、mag（ｉ）はそれぞれ（２０）、（２１）式で与えられる。さらに、全区間でsft（ｉ）とmag（ｉ）を求めれば、任意の位置における連続的な平面度差Δｈ（ｘ）を求めることができる。

【００４６】なお、マスクステージ３に固定したコーナキューブ１９ｃと反射鏡２１ｃとの間隔Ｌ、ないしはプレートステージ４に固定したコーナキューブ２０ｃと反射鏡２１ｅとの間隔Ｌを相当に狭くしたときには、両長

尺鏡７，８自体の形状を連続的に測定せずに、長尺鏡の互いに隣接する離散的な平面度差Δｈ（ｉ）とΔｈ（ｉ＋１）との間を、線形に補間することもできる。また、長尺鏡の大型化によって、長尺鏡の連続的な平面度が分割して計測された場合には、（２２）式の区間［ｉ×Ｌ≦ｘ≦（ｉ＋１）×Ｌ］で使用されるΔｋ（ｘ）、すなわちk_m（ｘ）とk_p（ｘ）は、同一の計測で得られたものが望ましい。

【００４７】

【発明の効果】以上のように、本発明による走査型露光装置及び測定方法によれば、長尺鏡の平面度に依存することなく、高い露光精度を確保することができる。

【図面の簡単な説明】

【図１】本発明による走査型露光装置の一実施例の構成を示す斜視図

【図２】長尺鏡の面精度を連続的に計測するときの配置図

【図３】暫定式によって生じる誤差を計測するために用いるマスクを示す平面図

【図４】誤差計測用マスクに用いるマークを示す拡大図

【図５】誤差計測用マスクのマークが転写されたプレートを示す平面図

【図６】２回の露光によって転写されたマークの像を示す拡大図

【図７】露光誤差分布を示す説明図

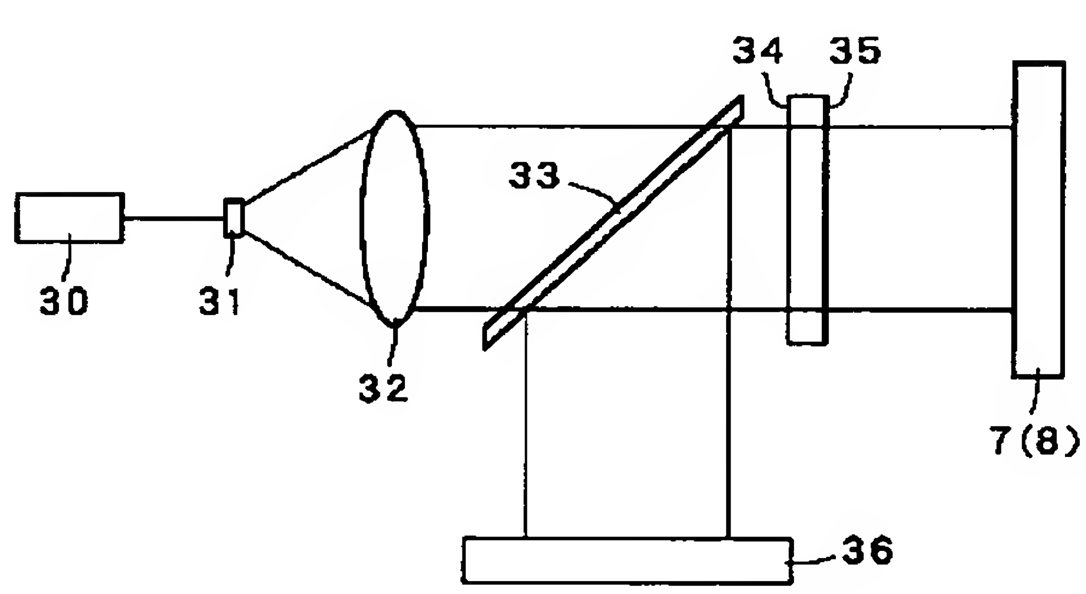
【図８】暫定式によって生じる誤差を計測するために用いる別の（ａ）マスクと（ｂ）プレートを示す平面図

【図９】図１の走査型露光装置を部分的に表わした斜視図である。

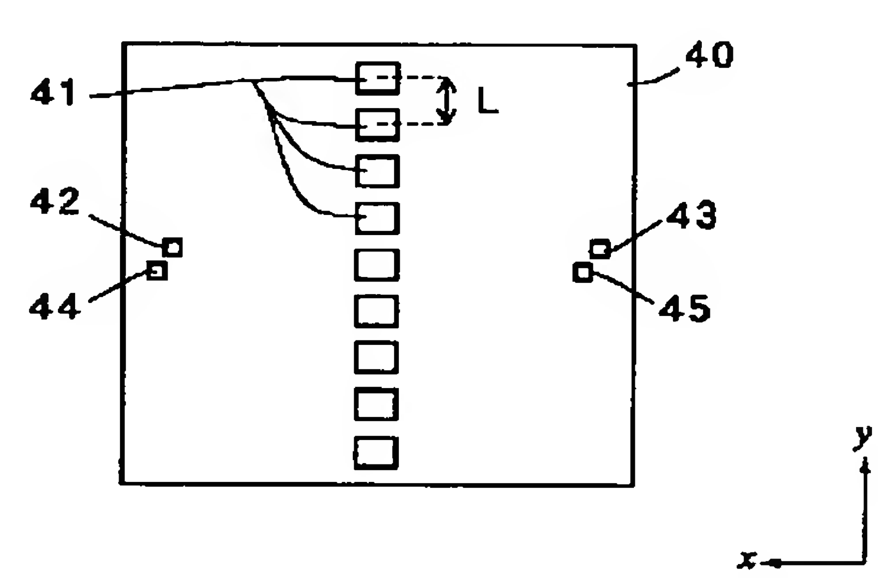
【符号の簡単な説明】

１…架台　２…キャリッジ
３…マスクステージ　４…プレートステージ
５…マスク　６…プレート
７…マスク用長尺鏡　８…プレート用長尺鏡
９、１０、１１…微動機　１２、１３…アライメント顕微鏡
１４ａ～１４ｅ…マスク照明領域　１５ａ～１５ｅプレート露光領域
I_{x1}、I_{x2}、I_{cx}、I_{my}、I_{py}、I_{ck}…干渉計
１６ａ、１７ａ、１８ａ、１９ａ、２０ａ、２１ａ…ビームスプリッタ
１６ｂ～１６ｅ、１７ｂ～１７ｅ、１８ｂ～１８ｅ…反射鏡
１９ｂ、２０ｂ、２１ｂ～２１ｅ…反射鏡
１９ｃ、２０ｃ…コーナキューブ
１９ｄ、１９ｅ、２０ｄ、２０ｅ…λ／４板
２５…制御装置　２６…記憶装置
３０…レーザー光源　３１…ビームエキスパンダ
３２…レンズ　３３…ハーフミラー
３４…裏面　３５…参照面
３６…検出器
４０…誤差計測用マスク　４１…マーク
４２、４３…マスク用アライメントマーク
４４、４５…プレート用アライメントマーク
４６、４７…プレート用アライメントマーク転写マーク
４８…誤差計測用プレート　４９…マーク転写マーク
５０…回帰直線
６０…誤差計測用マスク　６１…誤差計測用プレート
６２、６３…アライメントマーク

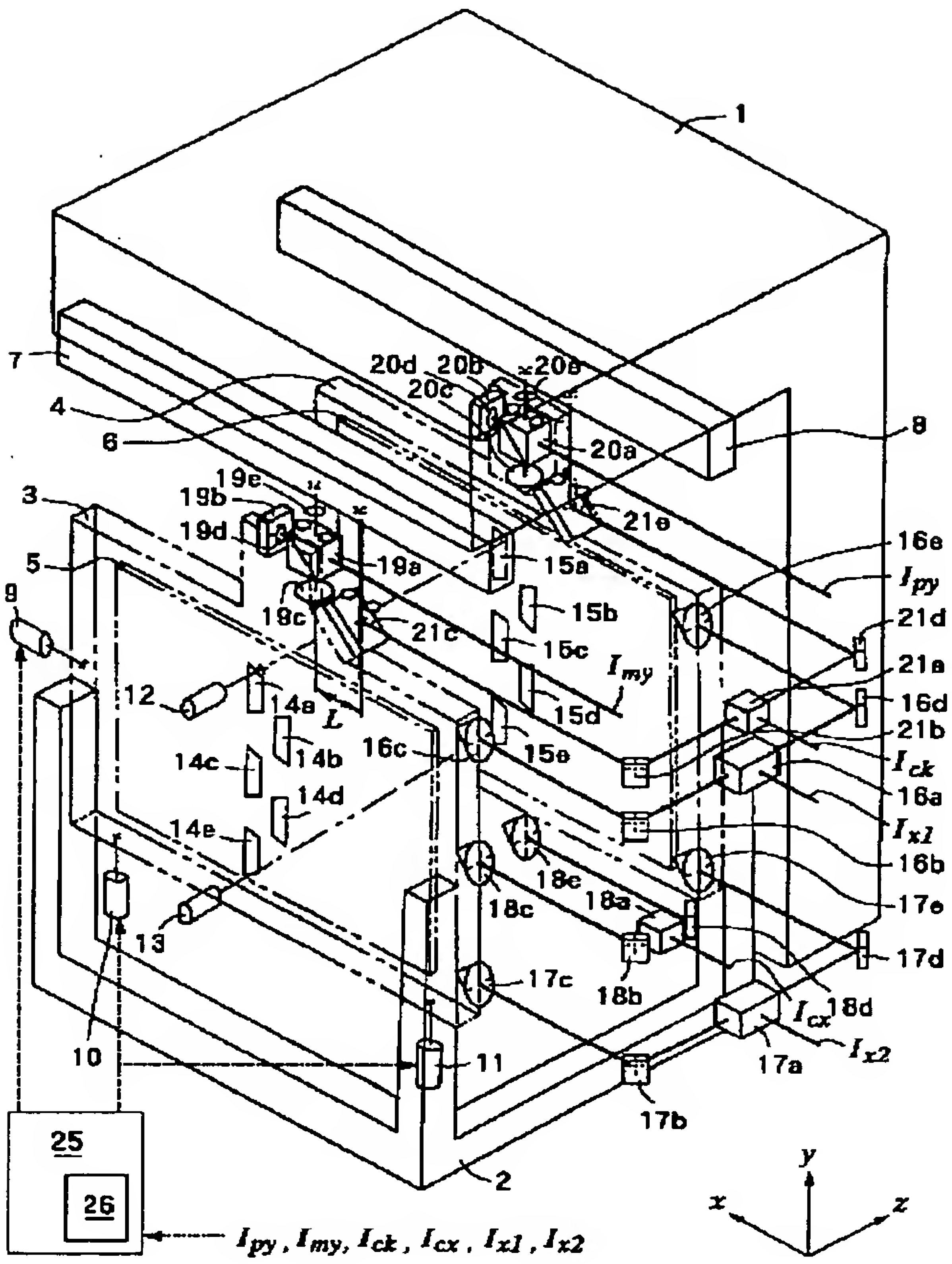
【図２】



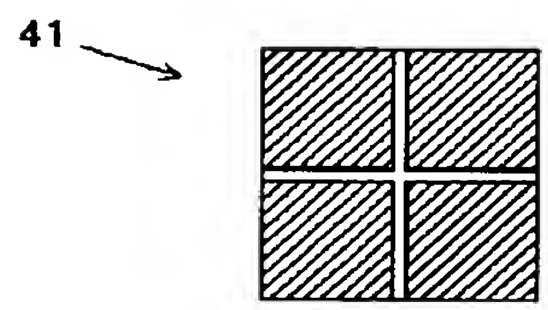
【図３】



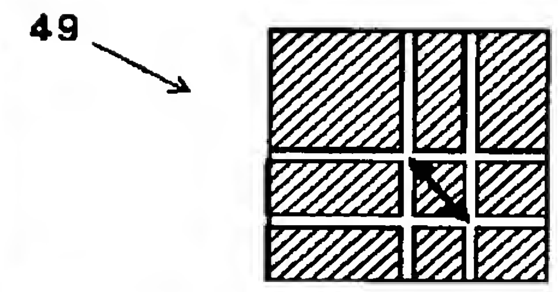
【図１】



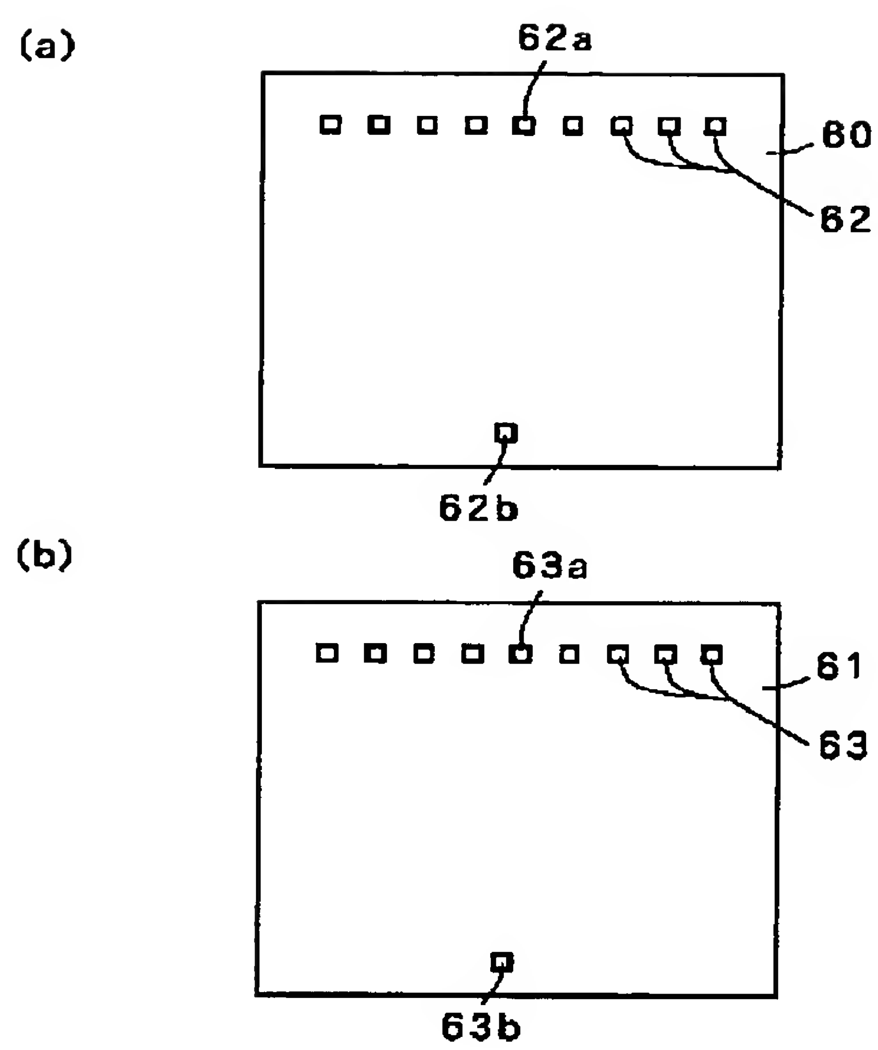
【図４】



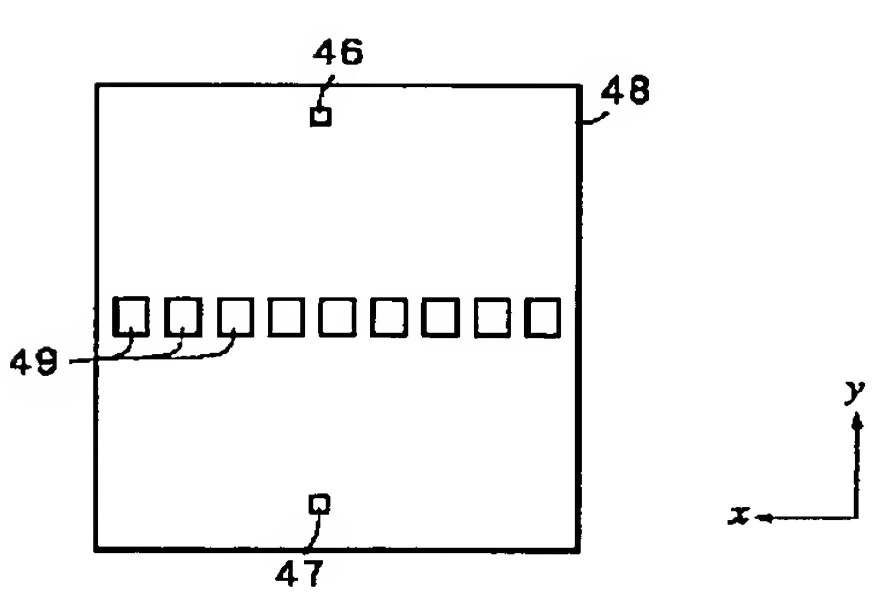
【図６】



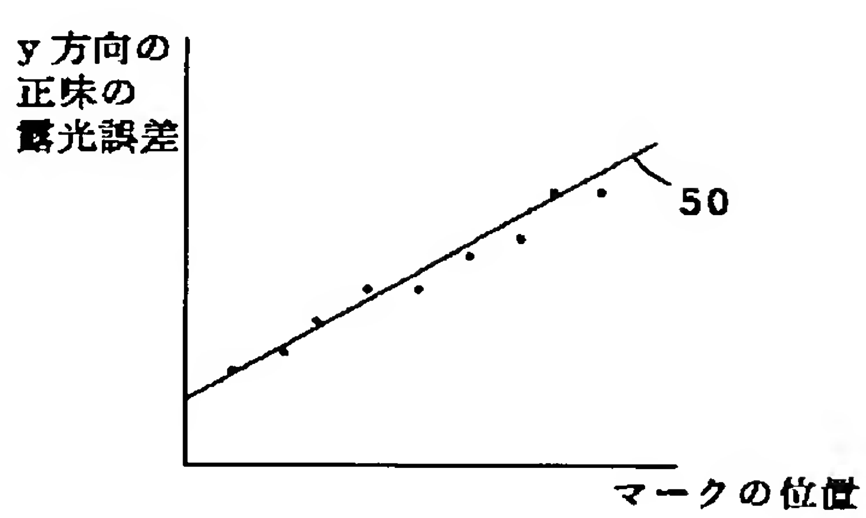
【図８】



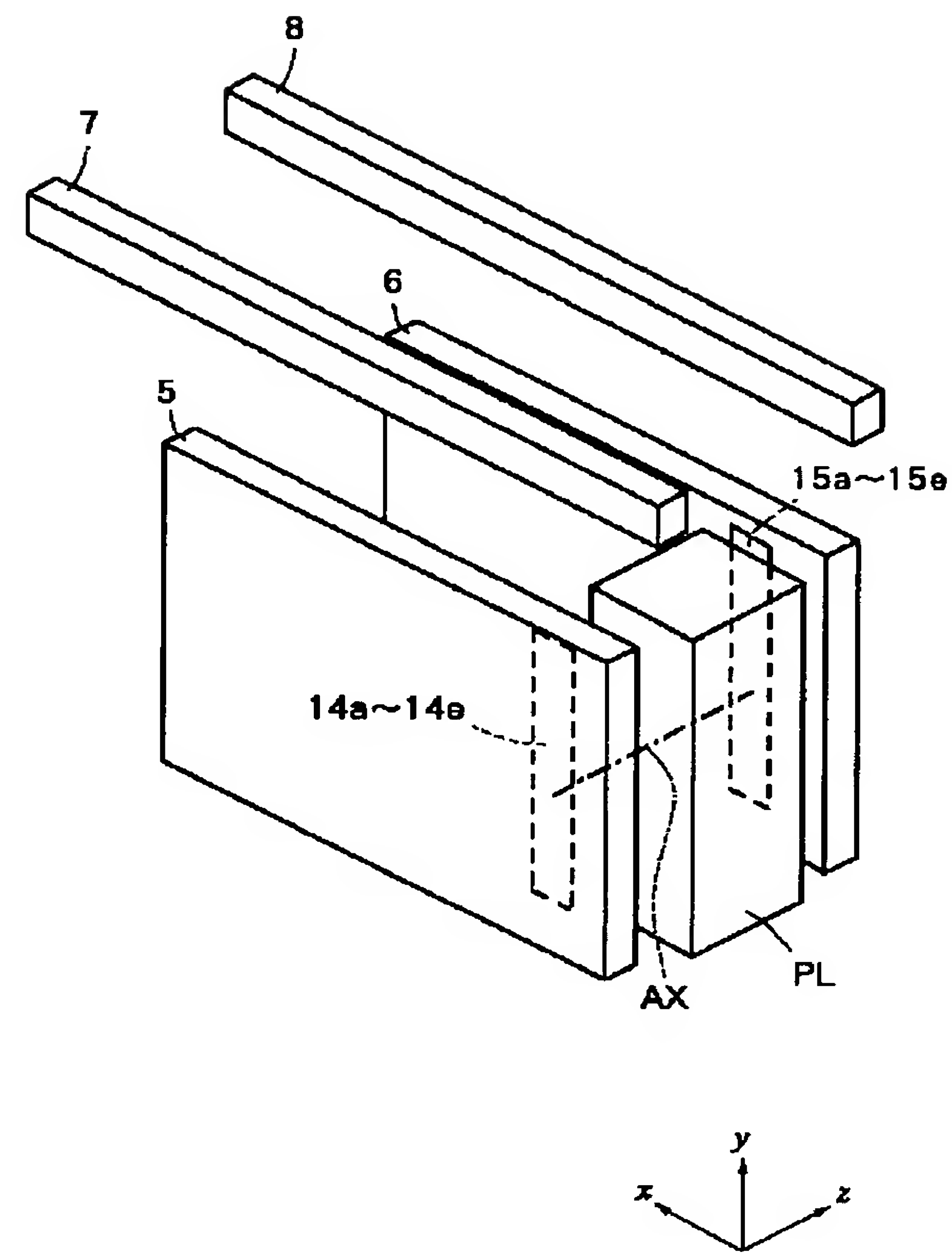
【図５】



【図７】



【図９】



.* NOTICES *

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CLAIMS

[Claim(s)]

[Claim 1] The scanned type aligner equipped with the mask which is characterized by providing the following and with which the pattern was formed, the projection optical system which projects the image of the pattern of the aforementioned mask on a sensitization substrate, and the 1st move mechanism in which the aforementioned mask and the aforementioned sensitization substrate are moved in the 1st direction which synchronizes and intersects perpendicularly with the optical axis of the aforementioned projection optical system to the aforementioned projection optical system. The 1st reflecting mirror with the reflector which is fixed along the 1st direction of the above and counters with the predetermined end face of the aforementioned mask. The 2nd reflecting mirror with the reflector which is fixed along the 1st direction of the above and counters with the predetermined end face of the aforementioned sensitization substrate. The 1st interference system which detects the amount about the distance of the predetermined end face of the aforementioned mask, and the 1st reflecting mirror of the above according to the aforementioned movement by the aforementioned 1st move mechanism. A storage means memorize the data about the flatness difference of the aforementioned reflector of the 1st reflecting mirror of the above, and the aforementioned reflector of the 2nd reflecting mirror of the above called for based on the detection result of the 2nd interference system which detects the amount about the distance of the predetermined end face of the aforementioned sensitization substrate, and the 2nd reflecting mirror of the above, and the 1st interference system of the above and the 2nd interference system of the above according to the aforementioned movement by the aforementioned 1st move mechanism.

[Claim 2] The scanned type aligner according to claim 1 characterized by providing the following. The 2nd move mechanism which moves at least one side of the aforementioned mask and the aforementioned sensitization substrate in the direction which intersects perpendicularly in the optical axis and the 1st direction of the above of the aforementioned projection optical system. Control means which control the aforementioned 2nd move mechanism during the aforementioned movement by the aforementioned 1st move mechanism based on the aforementioned data memorized by the aforementioned storage means.

[Claim 3] Data concerning [on a scanned type aligner according to claim 1 and] the aforementioned flatness difference are a scanned type aligner characterized by being complemented with the data about the flatness of the aforementioned reflector of the 1st reflecting mirror of the above before [above] fixation is carried out, and the aforementioned reflector of the 2nd reflecting mirror of the above.
[Claim 4] The scanned type exposure method which is made to move the aforementioned mask and the aforementioned sensitization substrate in the 1st direction which synchronizes and intersects perpendicularly with the optical axis of the aforementioned projection optical system to the aforementioned projection optical system, and exposes the image of the pattern of the aforementioned mask while projecting the image of the pattern of a mask characterized by providing the following on a sensitization substrate by the projection optical system. The 1st reflecting mirror which has the predetermined end face of the aforementioned mask, and the reflector which counters, and was fixed along the 1st direction of the above. The 1st step which detects dispersedly the amount about distance with the predetermined end face of the aforementioned mask according to the aforementioned movement. The 2nd reflecting mirror which has the predetermined end face of the aforementioned sensitization substrate, and the reflector which counters, and was fixed along the 1st direction of the above. The 2nd step which detects dispersedly the amount about distance with the predetermined end face of the aforementioned sensitization substrate according to the aforementioned movement, and the step which asks for the data about the flatness difference of the aforementioned reflector of the 1st reflecting mirror of the above, and the aforementioned reflector of the 2nd reflecting mirror of the above based on the above 1st and the detection result of the 2nd step.
[Claim 5] The step which asks for the data about the aforementioned flatness difference in the scanned type exposure method according to claim 4 is the scanned type exposure method characterized by asking based on the data about the flatness of the aforementioned reflector of the 1st reflecting mirror of the above before [above] fixation is carried out, and the aforementioned reflector of the 2nd reflecting mirror of the above.
[Claim 6] The scanned type exposure method characterized by including the step which moves at least one side of the aforementioned mask and the aforementioned sensitization substrate in the direction which intersects perpendicularly in the optical axis and the 1st direction of the above of the aforementioned projection optical system according to the data about the aforementioned flatness difference in the scanned type exposure method according to claim 4 or 5 during the aforementioned exposure.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention relates to a scanned type aligner, and relates to amendment of the position gap with the mask stage and plate stage especially in the middle of a scanning.
[0002]
[Problem(s) to be Solved by the Invention] The technology which carries out scanning exposure is indicated without making severe profile irregularity of the long mirror used as the criteria for measuring the relative position gap between the masks about a longitudinal

direction and plates which intersect perpendicularly with the both sides of the normal of a mask, and a scanning direction to Japanese Patent Application No. No. 184113 [eight to] prolonged in the scanning direction, since it corresponds to enlargement of the latest liquid crystal substrate. however, in this technology, when the wave of a short period is in a long mirror, it is kept highly precise on the level which can disregard the strike slip between a mask and a plate -- there was un-arranging [that things did not have the result] this invention makes it a technical problem to offer the scanned type aligner which can carry out scanning exposure with high precision, and its technique in view of this trouble, without being based on the profile irregularity of a long mirror.

[0003]

[Means for Solving the Problem] If it matches and explains to drawing 1 which is made in order that this invention may solve the above-mentioned technical problem, and expresses one example The mask (5) with which the pattern was formed, and the projection optical system which projects the image of the pattern of the aforementioned mask on a sensitization substrate (6), In the scanned type aligner equipped with the 1st move mechanism in which the aforementioned mask and the aforementioned sensitization substrate are moved in the 1st direction which synchronizes and intersects perpendicularly with the optical axis of the aforementioned projection optical system to the aforementioned projection optical system The 1st reflecting mirror with the reflector which is fixed along the 1st direction of the above and counters with the predetermined end face of the aforementioned mask (7), The 2nd reflecting mirror with the reflector which is fixed along the 1st direction of the above and counters with the predetermined end face of the aforementioned sensitization substrate (8), The 1st interference system which detects the amount about the distance of the predetermined end face of the aforementioned mask, and the 1st reflecting mirror of the above according to the aforementioned movement by the aforementioned 1st move mechanism (Imy, Ick, Ix1, Ix2), The 2nd interference system (Ipy, Ick, Ix1, Ix2) which detects the amount about the distance of the predetermined end face of the aforementioned sensitization substrate, and the 2nd reflecting mirror of the above according to the aforementioned movement by the aforementioned 1st move mechanism, It is the scanned type aligner characterized by establishing a storage means (26) to memorize the data about the flatness difference of the aforementioned reflector of the 1st reflecting mirror of the above, and the aforementioned reflector of the 2nd reflecting mirror of the above called for based on the detection result of the 1st interference system of the above, and the 2nd interference system of the above.

[0004] While this invention projects the image of the pattern of a mask (5) on a sensitization substrate (6) by the projection optical system, again In the scanned type exposure method which is made to move the aforementioned mask and the aforementioned sensitization substrate in the 1st direction which synchronizes and intersects perpendicularly with the optical axis of the aforementioned projection optical system to the aforementioned projection optical system, and exposes the image of the pattern of the aforementioned mask The 1st reflecting mirror which has the predetermined end face of the aforementioned mask, and the reflector which counters, and was fixed along the 1st direction of the above (7), The 1st step which detects the amount about distance with the predetermined end face of the aforementioned mask according to the aforementioned movement, The 2nd reflecting mirror which has the predetermined end face of the aforementioned sensitization substrate, and the reflector which counters, and was fixed along the 1st direction of the above (8), The 2nd step which detects the amount about distance with the predetermined end face of the aforementioned sensitization substrate according to the aforementioned movement, It is the scanned type exposure method characterized by including the step which asks for the data about the flatness difference of

the aforementioned reflector of the 1st reflecting mirror of the above, and the aforementioned reflector of the 2nd reflecting mirror of the above based on the above 1st and the detection result of the 2nd step.

[0005]

[Embodiments of the Invention] The form of operation of this invention is explained using a drawing. The outline composition of one example of the scanned type aligner by this invention is shown in drawing 1 . In the following explanation, the system of coordinates which make a scanning direction, i.e., lengthwise, a x axis, make the y-axis the longitudinal direction which intersects perpendicularly in the same field as a mask 5 in a x axis, and make the direction of a normal of a mask 5 the z-axis are taken. The lighting light injected from the light sources (un-illustrating), such as an extra-high pressure mercury lamp, is led to 5 lighting optical system (un-illustrating) through an optical fiber (un-illustrating) etc. Each lighting optical system is constituted including a fly eye lens, a field diaphragm (un-illustrating), etc., respectively. Each lighting light injected from each lighting optical system illuminates uniformly the lighting fields 14a-14e where it differs on a mask 5. Each flux of light which passed the mask 5 exposes the exposure fields 15a-15e where it differs on the plate 6 which is a sensitization substrate through the projection optical system PL with the five projection lens sections which perform image formation of actual size erection, respectively (refer to drawing 9), and carries out image formation of the image of the pattern of the lighting fields 14a-14e on a mask 5 on a plate 6 in this way. Although each lighting fields 14a-14e are separated, respectively and it is arranged, the addition width of face which integrated the width of face of the x directions of each lighting fields 14a-14e in the x directions is formed so that it may continue in the direction of y with the same width of face.

[0006] Each lighting optical system and each projection optical system are supported with the stand 1. The carriage 2 by which a run drive is carried out is carried in the x directions by the driving gear (un-illustrating) at the stand 1, and the mask stage 3 and the plate stage 4 are held at this carriage 2. The mask 5 is held at the mask stage 3, the plate 6 is held on the plate stage 4, and the whole pattern on a mask 5 is imprinted on a plate 6 by scanning carriage 2 in the x directions in this way. The mask stage 3 is constituted so that it may be supported by carriage 2 through the jogging machines 9-11, namely, the position of the x directions of a mask stage 3 may be moved slightly with the x direction jogging machine 9 and the position of the direction of y of a mask stage 3 and the hand of cut of the circumference of the z-axis can be moved slightly with the direction jogging machines 10 and 11 of y.

[0007] On the other hand, in order to amend the influence of the thickness nonuniformity of a plate 6, or an inclination and to make it simultaneously in agreement with the image formation side of a mask pattern, the plate stage 4 is supported by carriage 2 through the three or more direction jogging machines (un-illustrating) of z, and it is constituted so that jogging (auto-focusing) of the direction of z and the degree of tilt angle of the circumference of a x axis and the circumference of the y-axis (auto leveling) can be adjusted in this way. Moreover, the long mirror 7 for masks and the long mirror 8 for plates are being fixed to the stand 1. Both the long picture mirrors 7 and 8 are reflecting mirrors prolonged for a long time in the x directions, and the normal of the reflector has turned to the direction of y. The long mirror 7 for masks counters a mask stage 3, and is arranged, and the long mirror 8 for plates counters the plate stage 4, and is arranged.

[0008] Drawing 9 is the perspective diagram which expressed the scanned type aligner of drawing 1 partially. The projection optical system PL has the five projection lens sections arranged alternately in order to project the flux of light which passed through each field of the lighting fields 14a-14e on a plate 6. In addition, on behalf of the five projection lens

sections, it expresses with drawing 9 the projection optical system PL, and the optical axis of a projection optical system PL is indicated to be AX. It is arranged along the direction of X the long mirror 7 for masks and whose long mirror 8 for plates are the 1st direction which intersects perpendicularly with the optical axis AX of a projection optical system PL so that clearly from drawing 9 .

[0009] It returns to drawing 1 and the position and posture of a mask stage 3 and the plate stage 4 are supervised as follows by six interferometers Ix1, Ix2, Icx, Imy, Ipy, and Ick. The differential type interferometer Ix1 is first for measuring a relative position gap (vertical gap) of the x directions of a mask stage 3 and the plate stage 4. Namely, the laser beam bunch injected from the laser light source (un-illustrating) fixed to the stand 1 It is divided by beam-splitter 16a fixed to the stand 1, and each divided flux of light Reflect with the reflecting mirrors 16b and 16d fixed to the stand 1, respectively, and it is fixed to a mask stage 3 and the plate stage 4, respectively, and reflects with reflecting mirrors 16c and 16e. It reverses, is compounded by beam-splitter 16a, and interferes in an outward trip, and incidence is carried out to the receiver (un-illustrating) of an interferometer Ix1.

[0010] An interferometer Ix1 is for measuring a relative position gap (vertical gap) of the x directions of a mask stage 3 and the plate stage 4 in the position where the differential type interferometers Ix2 differ in the direction of y. That is, the laser beam bunch for interferometer Ix2 is divided by beam-splitter 17a, and it reflects with reflecting mirrors 17b and 17d, respectively, is fixed to a mask stage 3 and the plate stage 4, respectively, and reflects with reflecting mirrors 17c and 17e, and each divided flux of light reverses, is compounded by beam-splitter 17a, and carries out incidence of the outward trip to the receiver of an interferometer Ix2. In addition, an interval with the reflecting mirrors 16c and 17c fixed to the mask stage 3 and the interval with the reflecting mirrors 16e and 17e fixed to the plate stage 4 are equal, and set this interval to H henceforth. As for the position of the reflecting mirrors 16c and 17c on a mask stage 3, and the reflecting mirrors 16e and 17e on the plate stage 4, it is desirable that it is in the equal distance from the center of each stages 3 and 4.

[0011] The measured type interferometer Icx of the length is for measuring the travel of carriage 2. The laser beam bunch for Interferometers Icx is divided by beam-splitter 18a, and namely, each divided flux of light Reflect with the reflecting mirrors 18b and 18d fixed to the stand 1, respectively, and one flux of light is reflected by reflecting mirror 18c fixed on the mask stage 3. Reflecting the flux of light of another side by fixed mirror 18e fixed to the projection optical system, it reverses, is compounded by beam-splitter 18a, and interferes in an outward trip, and both the flux of lights carry out incidence to the receiver of Interferometer Icx. In this way, by Interferometer Icx, the distance of the x directions of a mask stage 3 and fixed mirror 18e is measured.

[0012] The measured type interferometer Imy of the length is for measuring the distance of the direction of y of a mask stage 3 and the long mirror 7 for masks. Moreover, the measured type interferometer Ipy of the length is for measuring the distance of the direction of y of the plate stage 4 and the long mirror 8 for plates. Since both the interferometers Imy and Ipy are the same composition, the explanation about Interferometer Imy is indicated out of a parenthesis, and the explanation about Interferometer Ipy is indicated in a parenthesis. That is, the laser beam bunch for interference systems Imy (Ipy) is divided into the two flux of lights by beam-splitter 19a (20a) fixed to the mask stage 3 (plate stage 4). this -- two -- a ** -- the flux of light -- inside -- a beam splitter -- 19 -- a (20a) -- having penetrated -- the flux of light -- a mask stage -- three (plate stage 4) -- a top -- arranging -- having had -- lambda -- /-- four -- a board -- 19 -- d (20d) -- a passage -- a mask stage -- three (plate stage 4) -- a top -- arranging -- having had -- a reflecting mirror -- 19 -- b (20b) -- reflecting -- again -- The flux of light which passed along 19d (20d) of lambda/4 boards Beam-splitter

19a (20a), Cube-corner-reflector 19c arranged on the mask stage 3 (plate stage 4) (20c), beam-splitter 19a (20a) -- respectively -- reflecting -- 19d (20d) of lambda/4 boards -- a passage -- reflecting mirror 19b (20b) -- reflecting -- 19d (20d) of lambda/4 boards, and beam-splitter 19a (20a) -- respectively -- a passage -- an interference system Imy (Ipy) -- incidence is carried out to a receiver

[0013] the flux of light reflected up by beam-splitter 19a (20a) of the flux of lights divided by beam-splitter 19a (20a) -- lambda / 4 board 19e (20e) -- a passage -- the long mirror 7 (8) -- reflecting -- lambda / 4 board 19e (20e), and beam-splitter 19a (20a) -- respectively -- a passage -- cube-corner-reflector 19c (20c) -- reflecting . the flux of light reflected by cube-corner-reflector 19c (20c) -- beam-splitter 19a (20a), and lambda/4 board 19e (20e) -- respectively -- a passage -- the long mirror 7 (8) -- reflecting -- lambda / 4 board 19e (20e) -- a passage -- beam-splitter 19a (20a) -- reflecting -- having -- an interference system Imy (Ipy) -- incidence is carried out to a receiver Thereby, the flux of light divided into the two flux of lights by beam-splitter 19a (20a) is again compounded by beam-splitter 19a (20a), and it interferes in it, and it carries out incidence to a receiver.

[0014] The differential type interferometer Ick is for measuring a relative position gap of the direction of y of a mask stage 3 and the plate stage 4 through both the long picture mirrors 7 and 8. That is, the laser beam bunch for Interferometers Ick is divided by beam-splitter 21a, each divided flux of light is reflected with the reflecting mirrors 21b and 21d fixed to the stand 1, respectively, it reflects by reflecting mirror 21c on a mask stage 3, and one flux of light is reflected in the long mirror 7 for masks. It reflects by reflecting mirror 21e on the plate stage 4, and the flux of light of another side is reflected in the long mirror 8 for plates. Both the flux of lights reverse, are compounded by beam-splitter 21a, interfere in an outward trip, and carry out incidence to the receiver of Interferometer Ick. In addition, the interval of the x directions of cube-corner-reflector 20c and reflecting mirror 21e which were fixed to the interval and the plate stage 4 of the x directions of cube-corner-reflector 19c and reflecting mirror 21c which were fixed to the mask stage 3 is equal, and sets this interval to L henceforth.

[0015] The position of carriage 2 is set to x, the relative amount of position gaps of the x directions of a mask stage 3 and the plate stage 4 (the amount of vertical gaps) is set to deltaX (x), the relative amount of position gaps of the direction of y (the amount of strike slips) is set to deltaY (x), and the relative amount of angle gaps of the circumference of the z-axis is set to deltaT (x). Moreover, the flatness difference of both the long picture mirrors 7 and 8 is set to deltah (x). Flatness difference deltah is the relative amount of position gaps of the direction of y of the reflector of the long mirror 7 for masks, and the reflector of the long mirror 8 for plates (the amount of strike slips). When the measurement value of each interferometers Ix1, Ix2, Icx, Imy, Ipy, and Ick is expressed as Ix1, Ix2, Icx, Imy, Ipy, and Ick using the respectively same character, it is deltaX(x) = (Ix1+Ix2)/2. .... (1)

deltaT (x) =(Ix1-Ix2)/H .... (2)

deltaY (x) =Imy-Ipy-deltah (x) .... (3)

It becomes.

[0016] The value of angle gap deltaT of vertical gap deltaX of (1) formula and (2) formulas is immediately acquired from the measurement value of interferometers Ix1 and Ix2 among the above-mentioned (1) - (3) formulas. Moreover, about strike slip deltaY of (3) formulas, flatness difference deltah is stored in the storage 26 in a control unit 25 as a function of the position x of carriage 2, and strike slip deltaY is calculated from this deltah (x) and measurement value of Interferometers Imy and Ipy. In this way, the relative physical relationship of the mask stage 3 at the time of scanning exposure and the plate stage 4 is kept constant by driving the jogging machines 9-11 and tuning the position of a mask stage 3 finely in a x-y side with a control unit 25, to vertical gap deltaX in a x-y side, strike slip

deltaY, and angle gap deltaT.

[0017] How to ask below for flatness difference delta[of both the long picture mirrors 7 and 8] h (x) is explained. This flatness difference deltah (x) is dependent on the installation posture to the mirror-plane configuration of each long mirror 7 and 8 the very thing, and the stand 1 of each long mirrors 7 and 8. this example measures continuously the mirror-plane configuration of each long mirror 7 and 8 the very thing in one side. By measuring dispersedly flatness difference delta[when attaching each long mirrors 7 and 8 in a stand 1 in another side] h (x), and interpolating the inside of each section of flatness difference deltah for which after an appropriate time was asked dispersedly with the difference of the continuous configuration of both the long picture mirrors 7 and 8 It asks for flatness difference deltah as a continuous function of x.

[0018] Then, how to search for continuously the mirror-plane configuration of each long mirror 7 and 8 the very thing is explained first. Drawing 2 is drawing having shown the outline for measuring continuously the profile irregularity of each long mirrors 7 and 8. It is efficient to perform this measurement to serve both as a check and measurement of profile irregularity at the time of the polish end of the long mirrors 7 and 8 before the inclusion to a stand 1. Moreover, as for the posture of the long mirrors 7 and 8 at the time of measurement, it is desirable to suppose that it is the same as that of the posture when including in a stand 1.

[0019] The laser beam bunch injected from the laser light source 30 can extend **** with the beam expander 31, and serves as a parallel ray through a lens 32. Subsequently, a laser beam penetrates a one-way mirror 33, it reflects in respect of [35] the reference prepared in the last side of the Fizeau element, and a part of transmitted light reverses an outward trip, and it returns to a one-way mirror 33. The rear face 34 of the reference side 35 is coated with the antireflection film. On the other hand, it reflects in the long mirror 7 (or long mirror 8 for plates) for masks, and the laser beam which penetrated the reference side 35 reverses an outward trip, and returns to a one-way mirror 33. It interferes, and reflects by the one-way mirror 33, and the laser beam reflected in respect of [35] reference and the laser beam reflected in the long mirror 7 (8) reach a detector 36. In this way, it becomes possible to be able to measure the profile irregularity of the long mirror 7 (8) to the reference side 35 with a detector 36, namely, to ask for the flatness in the arbitrary points of the long mirror 7 (8).

[0020] In addition, although, as for the long mirror 7 (8), a bird clapper is expected for a long time with enlargement of a liquid crystal substrate, when it becomes longer than the reference side 35, the whole surface can be measured by shifting the long mirror 7 (8) and measuring multiple times. However, it is necessary to make the measure point by the interferometers Imy, Ipy, and Ick later mentioned in this case overlap, and to measure. Moreover, although the Fizeau interferometer was used for measurement of the profile irregularity of the long mirror 7 (8) in drawing 2 , the measurement method was not restricted to this.

[0021] Next, how to measure the flatness difference of a long mirror dispersedly is explained. Measurement is measured at every fixed measurement interval L, scanning carriage 2. A measurement end fixes a mask stage 3 and the plate stage 4 relatively, namely, the jogging machines 9-11 do not drive it. Let the interval L which measures be the interval of the x directions of the position which the flux of light of Interferometer Imy or Interferometer Ipy reflects in the long mirror 7 or the long mirror 8, and the position which the flux of light of Interferometer Ick reflects in the long mirror 7 or the long mirror 8. Measurement is performed as follows. The value of the interferometers Imy, Ipy, and Ick when moving carriage 2 to the end of the long mirrors 7 and 8 is measured. Subsequently, measuring the position of carriage 2 with Interferometer Icx, only L moves the position of

carriage 2 and the value of Interferometers Imy, Ipy, and Ick is measured in the position. Like the following, whenever only L moves the position of carriage 2, the value of Interferometers Imy, Ipy, and Ick is measured.

[0022] Below, since it is easy, the measurement value of the interferometers Imy, Ipy, and Ick in the dispersed measurement position i on a long mirror is marked as Imy (i), Ipy (i), and Ick (i), respectively. That is, when a dispersed position is meant, Variable i is used, and Variable x is used when a continuous position is meant. In addition, in the position of the same carriage 2, Imy (i), Ipy (i), and Ick (i-1) are measured clearly. Moreover, the value of the interferometer in a measurement starting position is set to Imy (1), Ipy (1), and Ick (0).

[0023] Interferometer Imy is measuring the distance of the direction of y of a mask stage 3 and the long mirror 7 for masks, and Interferometer Ipy is measuring the distance of the direction of y of the plate stage 4 and the long mirror 8 for plates. Therefore, the rolling error (rotation of the circumference of a x axis) of carriage 2 and the offset at the time of interferometer reset are included in the measurement value of both these interferometers Imy and Ipy in addition to flatness difference deltah of both the long picture mirrors 7 and 8. The flatness difference of both the long picture mirror in the measurement position i is set to deltah (i), the amount of rolling is set to r (i), and the offset at the time of reset of both the interferometers Imy and Ipy is set to A and B, respectively.

[0024] It is newly Iy(i) **Imy(i)-Ipy about Iy (i) as a difference of the measurement value of both the interferometers Imy and Ipy (i). .... (4)

A definition materializes the following formula.

Iy(i) **Imy(i)-Ipy (i)

= deltah(i)+r(i)+A-B .... (5)

(5) Among a formula, Iy (i) is measured value and the right-hand side's is strange.

[0025] Moreover, Interferometer Ick is measuring the position gap of the direction of y of a mask stage 3 and the plate stage 4 through both the long picture mirrors 7 and 8. Therefore, the position gap resulting from vertical gap deltaX of a mask stage 3 and the plate stage 4 and angle gap deltaT of the circumference of the z-axis other than the offset C at the time of the error r resulting from flatness difference deltah of both the long picture mirrors 7 and 8 and rolling of carriage 2 and interferometer reset is further included in the measurement value of Interferometer Ick. Moreover, the amount of rolling contained in the measurement value of the interferometers Imy, Ipy, and Ick measured simultaneously is equal. Therefore, Ick (i-1) is expressed with the following formula.

Ick(i-1) =deltah(i-1) +r (i) +C +deltaX(i-1) +deltaT(i-1) -H .... (6)

[0026] Since vertical gap deltaX and angle gap deltaT are measured value, if they define Ick' by (7) formulas, (6) formulas will turn into (8) formulas.

Ick'(i) ** -- Ick(i)-deltaX(i)-deltaT(i) -H .... (7)

Ick'(i-1) =deltah(i-1) +r (i) +C .... (8)

(8) Among a formula, Ick' (i-1) is measured value, and the right-hand side's is strange.

[0027] Furthermore, if (9) formulas define deltaH in order to eliminate the error r resulting from rolling of carriage 2, deltaH will become like (5) formulas and (8) formulas to (10) formulas.

deltaH(i) **Iy(i)-Ick' (i-1) .... (9)

deltaH(i) =deltah(i)-deltah(i-1)+A-B-C .... (10)

(10) Among a formula, deltaH (i) is calculated from the measurement value of interferometers Imy, Ipy, Ick, Ix1, and Ix2, and the right-hand side's is strange.

[0028] If the sum from i= 1 to i=k (k>=1) of deltaH (i) is set to S (k) and the position k of a long mirror is newly marked as a position i S(i) **deltaH(1)+deltaH [.. (11a)] (2) + ... +deltaH (i)

S(i) =deltah(1)-deltah(0)+A-B-C + deltah(2)-deltah(1)+A-B-C + ... + +deltah(i)-deltah(i-

1)+A-B-C =deltah(i)-deltah (0) +(A-B-C) xi (i>=1)
.... (11b)
It becomes. (11b) Among a formula, S (i) is measured value and the right-hand side's is strange. flatness difference delta[of a long mirror / in / a position i / in this way (11b) / from a formula] / h (i) delta -- h(i) =S(i)+deltah(0)-(A-B-C) xi (i>=1)
.... (12)
It becomes. If it sets with S(0) **0 at the time of i= 0, (12) formulas will be realized also at the time of i= 0.
[0029] (12) Among the right-hand side of a formula, S (i) is measured value and deltah (0) and x(A-B-C) i are unknowns. Among these, since deltah (0) is always fixed offset irrespective of the measurement position i of a long mirror, it does not become an error by amount of strike slips delta[between a mask stage 3 and the plate stage 4] Y's (x)'s not changing, namely, carrying out alignment of a mask stage 3 and the plate stage 4 so that more clearly than (3) formulas. On the other hand, since x(A-B-C) i changes to alignment depending on the position i of a long mirror, it needs to ask for the coefficient (A-B-C). Then, how to ask for a coefficient (A-B-C) next is shown.
[0030] First, as the 1st process, in order to measure S in (12) formulas (i), carriage 2 is scanned and the measurement value of each interferometer is measured. At this time, amount of vertical gaps deltaX between a mask stage 3 and the plate stage 4 is continuously measured by (1) formula like previous statement, and amount of angle gaps deltaT in a x-y side can scan carriage 2, keeping constant these amounts delta X and delta T of gaps, since it is continuously measured by (2) formulas. However, flatness difference deltah (x) is not only strange, but since discrete-value deltah (i) is strange, amount of strike slips deltaY cannot keep amount of strike slips deltaY constant. Then, first, carriage 2 is scanned without performing adjustment of a strike slip at all, and x= 0 at that time, L, 2xL, ..., ixL, the measurement value Imy of Interferometers Imy and Ipy in .. (i), and Ipy (i) are measured. Subsequently, as the 2nd process, it asks for S (i) by the formula (11a).
[0031] Subsequently, as the 3rd process, in order to calculate (A-B-C) in (12) formulas, the mask 40 for error measurement shown in drawing 3 is set to a mask stage 3, the plate for error measurement is set to the plate stage 4, and 1st scanning exposure is performed. However, although S in (12) formulas (i) became known, since the coefficient (A-B-C) is strange, it disregards this coefficient (A-B-C), namely, it is deltah(i) =S as a provisional formula of the flatness difference of both the long picture mirror (i). .... (13)
********. Moreover, since i is a discrete value, it interpolates between deltah (i) and deltah (i+1) by the primary formula. That is, the relation between the measurement position i and the position x of the carriage 2 measured with Interferometer Icx is expressed with the following formula when the value of the interferometer Icx in a measurement starting position is set to 0.
x=ixL .... (14)
[0032] Therefore, provisional formula delta[of the flatness difference of both the long picture mirror in case carriage 2 is between the measurement position i on a long mirror and i+1] h (x) is expressed with the following formula.
deltah(x) = [deltah(i+1)-deltah (i)] x (x/L-i)
+ deltah (i) .... (15)
Carriage 2 is scanned asking for amount of strike slips deltaY between a mask stage 3 and the plate stage 4, and keeping constant this amount of strike slips deltaY by (3) formulas, since the estimate of the flatness difference of both the long picture mirror is continuously obtained by (13) formulas and (15) formulas in this way.
[0033] Drawing 3 shows the mask 40 for error measurement, and two or more marks 41 are drawn by this mask 40 in the x directions at one train, and are drawn in the direction of y

again at every interval L. As for the interval of the direction of y of a mark 41, it is desirable to make it in agreement with the measurement interval L in dispersed flatness measurement of both the long picture mirror. Drawing 4 shows the enlarged view of one mark 41, and is a pattern for exposure position detection. In this drawing, the slash section is a shading field and a cross-like portion is a light transmission field. Although the cross hair was used for exposure position detection here, what mark may be used as long as it is the mark which can detect an exposure position. Moreover, the alignment marks 42 and 43 for masks of a couple and the alignment marks 44 and 45 for plates of a couple are drawn by the mask 40 for error detection. both the marks 42 and 43; -- it shifts a little to the both sides of x directions and the direction of y, and 44 and 45 are arranged to them, as shown in drawing 3

[0034] A plate is developed after scanning exposure of a mask 40. As shown in a plate 48 at drawing 5 , the imprint mark (un-illustrating) of the alignment marks 42 and 43 for masks and the imprint marks 46 and 47 of the alignment marks 44 and 45 for plates other than the imprint mark 49 of two or more marks 41 are imprinted. Subsequently, both a mask 40 and a plate are rotated 90 degrees, it sets to a mask stage 3 and the plate stage 4, respectively, and alignment of the alignment marks 42 and 43 for masks on a mask 40 and the alignment mark imprint marks 46 and 47 for plates on a plate 48 is performed. namely, both the marks 42 and 43; -- the relative position error of 46 and 47 -- the alignment microscopes 12 and 13 -- measuring -- the mark motives 9-11 -- driving -- both the marks 42 and 43; -- the position of 46 and 47 is doubled and 2nd exposure is performed after an appropriate time

[0035] It shifts in the alignment marks 42 and 43 for masks on a mask 40, the alignment marks 44 and 45x for plates, and the direction of y a little, and is arranged, and alignment of the alignment marks 42 and 43 for masks and the imprint mark of the alignment mark for plates was carried out at the time of the 2nd exposure. Therefore, between the 1st exposure and the 2nd exposure, it means that only the interval of the alignment marks 42 and 43 for masks and the alignment marks 44 and 45 for plates had shifted and exposed the mask 40 and the plate 48.

[0036] Consequently, the image 49 of two or more marks 41 obtained by two exposure turns into an image with two cross hairs, as shown in drawing 6 . The amount of gaps of the net between both cross hairs can be known by measuring the interval of both cross hairs under a microscope etc., and deducting the amount of position gaps of a mask 40 and a plate 48 from this measured value. Control of the jogging machines 9-11 is correctly controlled in the x directions, and is controlled by the provisional formula in the direction of y here. Therefore, between a mark 41 and its image, there is no gap in the x directions and only the error by having controlled by the provisional formula produces a position gap in the direction of y. Namely, in the 1st exposure, since there is no gap between a mark 41 and its image in the x directions and it was rotating 90 degrees at the time of the 2nd exposure, speaking of the arrangement at the time of the 2nd exposure, there is no gap between a mark 41 and its 1st image in the direction of y. Moreover, between a mark 41 and its 2nd image, only the error by having controlled by the provisional formula in the direction of y produces a position gap about the arrangement at the time of the 2nd exposure. Therefore, by measuring the amount of gaps of the net of the direction of y between both cross hairs, the error by having controlled by the provisional formula can be known.

[0037] Subsequently, it asks for a coefficient (A-B-C) as the 4th process. Drawing 7 is drawing which took the position i of a mark 41 along the horizontal axis, and plotted the amount of position gaps of the net of the direction of y, i.e., a longitudinal direction, on the vertical axis. The amount of position gaps of lateral net is -deltah(0)+(A-B-C) xi. .... (16)

Since it becomes, if it asks for a regression line 50 from the point which drawing 7 plotted, the inclination will serve as a coefficient (A-B-C). It can ask for dispersed flatness difference deltah (i) of both the long picture mirror from (12) formulas in this way.

[0038] In addition, in each measure point where control of the jogging machine in the 3rd process measured S (i), the right control is performed except for the point that x(A-B-C) i is disregarded. Therefore, as for the measure point which measures the net amount of strike slips, it is desirable to make it in agreement with the measure point when asking for S (i). It is because there is a possibility that elements other than x(A-B-C) i may be added when the net amount of strike slips is measured points other than the measure point when asking for S (i). In order to make in agreement the measure point which measures the net amount of strike slips, and the measure point when asking for S (i), it is necessary to make the interval of a mark 41 first in agreement with the measurement interval L when asking for S (i). Subsequently, what is necessary is to set a mask 40 by arrangement of the 2nd exposure, and just to let the place which moved carriage by the integral multiple of L be a criteria position from the place whose mark 41 on a mask 40 corresponds with an exposure position, in case you decide the criteria position of the scanning direction of carriage 2, in order to make the measure point itself in agreement. In addition, naturally you may reverse the sequence of the 1st exposure and the 2nd exposure.

[0039] Moreover, when the measure point which measures the net amount of strike slips in this way, and the measure point when asking for S (i) are made in agreement, especially control of the jogging machine in the mid-position of each measure point does not pose a problem. Therefore, although between each measure point was only interpolated to alignment in this example, between each measure point can also be interpolated according to the actual flatness difference of both the long picture mirror, for example. Thus, the technique of interpolating between each measure point according to the actual flatness difference of both the long picture mirror is effective when it is difficult to make in agreement the measure point which measures the net amount of strike slips, and the measure point when asking for S (i).

[0040] Moreover, by two exposure, it can replace with the method of measuring a position gap of the direction of y dispersedly, and a position gap of the direction of y can also be measured dispersedly as follows, without exposing. That is, as it is indicated in (b) as drawing 8 (a), to the mask [for error measurement] 60, and end side of the direction of y of a plate 61, two or more alignment marks 62 and alignment marks 63 are arranged in the x directions at intervals of L, respectively, and alignment mark 62b and alignment mark 63b are arranged at the other end side of the direction of y, respectively. Positioning of a mask 60 and a plate 61 is performed by setting this mask 60 and plate 61 to a mask stage and a plate stage, respectively, carrying out alignment of one alignment mark 62a of two or more alignment marks 62 on a mask 60, and the one alignment mark 63a of two or more alignment marks 63 on a plate 61, and carrying out alignment of alignment mark 62b on a mask 60, and the alignment mark 63b on a plate 61.

[0041] Subsequently, amount of vertical gaps deltaX is correctly controlled by (1) formula, amount of angle gaps deltaT in a x-y side is correctly controlled by (2) formulas, and amount of strike slips deltaY scans carriage 2, controlling by (3) formulas using the provisional formula of the flatness difference of both the long picture mirror obtained by (13) formulas and (15) formulas. And the error of the direction of y of two or more alignment marks 62 on a mask 60 and two or more alignment marks 63 on a plate 61 is measured using the alignment microscope 12. A measurement end does not amend the error measured under the alignment microscope 12 in that case. If the position of the alignment marks 62 and 63 is taken along a horizontal axis and the measurement error of the direction of y is plotted on a vertical axis after an appropriate time, since the same result as drawing

7 is obtained, it can ask for dispersed flatness difference deltah (i) of both the long picture mirror.

[0042] Next, it asks for flatness difference delta[of the long mirror in arbitrary positions] h (x) by compounding the mirror-plane configuration of each long mirror 7 and 8 the very thing measured with dispersed flatness difference deltah (i) and the interferometer of both the long picture mirror as the 5th process. When flatness of the mask side long picture mirror 7 measured with the interferometer is set to km (x) and flatness of the plate side long picture mirror 8 is set to kp (x), flatness difference delta[of both the long picture mirror in the posture measured with the interferometer] k (x) is deltak(x) =km(x)-kp (x).
It becomes.

[0043] Composition with flatness difference delta[of both the long picture mirror in the posture measured with dispersed flatness difference deltah (i) and the interferometer of both the long picture mirror] k (x) each section [-- it carries out by moving deltak (x) in the direction of y, and expanding or reducing in the direction of y so that deltak (x) may be divided into every i and i+1] and it may be in agreement with deltah (i) and deltah (i+1) at the ends of the section namely, -- if movement magnitude added to deltak (x) for every section is set to sft (i) and the inclination added for every section is set to mag (i) delta --
h(i) =deltak(x)+sft(i)+mag(i) x (x-ixL)
[ixL<=x<=(i+1) xL] .... (17)
It becomes.

[0044] In x=ixL deltah(i) =deltak(ixL)+sft (i) .... (18)
coming out -- it is -- x=(i+1) xL -- setting -- delta -- h(i+1) =deltak(i+1) (xL)+sft(i)+mag(i) xL .... (19)
Since come out and it is sft(i) =deltah(i)-deltak (ixL) .... (20)
mag(i) =[deltah(i+1)-deltak (i+1) (xL)
- DeltaH (I) +DeltaK(IxL)]/L .... (21)
It becomes.

[0045] therefore, continuous flatness difference deltah (x) of the long mirror in section ixL<=x<=(i+1) xL delta -- h(x) =deltak(x)+sft(i)+mag(i) x (x-ixL)
.... (22)
It becomes. However, sft (i) and mag (i) are given by (20) and (21) formulas, respectively. Furthermore, if sft (i) and mag (i) are calculated by the entire interval, it can ask for continuous flatness difference deltah (x) in arbitrary positions.

[0046] In addition, the interval L of cube-corner-reflector 19c and reflecting mirror 21c which were fixed to the mask stage 3 or when the interval L of cube-corner-reflector 20c and reflecting mirror 21e which were fixed to the plate stage 4 is narrowed fairly Between dispersed flatness difference deltah (i) and deltah (i+1) of a long mirror which adjoin mutually can also be interpolated to alignment, without measuring continuously the configuration of both the long picture mirror 7 and 8 the very thing. Moreover, when the continuous flatness of a long mirror divides and is measured by enlargement of a long mirror, as for deltak used in the section [ixL<=x<=(i+1) xL] of (22) formulas (x), i.e., km, (x), and kp (x), what was obtained by the same measurement is desirable.

[0047]

[Effect of the Invention] As mentioned above, according to the scanned type aligner and measuring method by this invention, a high exposure precision can be secured, without being dependent on the flatness of a long mirror.

TECHNICAL FIELD

[The technical field to which invention belongs] this invention relates to a scanned type aligner, and relates to amendment of the position gap with the mask stage and plate stage especially in the middle of a scanning.

EFFECT OF THE INVENTION

[Effect of the Invention] As mentioned above, according to the scanned type aligner and measuring method by this invention, a high exposure precision can be secured, without being dependent on the flatness of a long mirror.

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] The technology which carries out scanning exposure is indicated without making severe profile irregularity of the long mirror used as the criteria for measuring the relative position gap between the masks about a longitudinal direction and plates which intersect perpendicularly with the both sides of the normal of a mask, and a scanning direction to Japanese Patent Application No. No. 184113 [eight to] prolonged in the scanning direction, since it corresponds to enlargement of the latest liquid crystal substrate. however, in this technology, when the wave of a short period is in a long mirror, it is kept highly precise on the level which can disregard the strike slip between a mask and a plate -- there was un-arranging [that things did not have the result] this invention makes it a technical problem to offer the scanned type aligner which can carry out scanning exposure with high precision, and its technique in view of this trouble, without being based on the profile irregularity of a long mirror.

MEANS

[Means for Solving the Problem] If it matches and explains to drawing 1 which is made in order that this invention may solve the above-mentioned technical problem, and expresses one example The mask (5) with which the pattern was formed, and the projection optical system which projects the image of the pattern of the aforementioned mask on a sensitization substrate (6), In the scanned type aligner equipped with the 1st move mechanism in which the aforementioned mask and the aforementioned sensitization substrate are moved in the 1st direction which synchronizes and intersects perpendicularly with the optical axis of the aforementioned projection optical system to the aforementioned projection optical system The 1st reflecting mirror with the reflector which is fixed along the 1st direction of the above and counters with the predetermined end face of the aforementioned mask (7), The 2nd reflecting mirror with the reflector which is fixed along the 1st direction of the above and counters with the predetermined end face of the aforementioned sensitization substrate (8), The 1st interference system which detects the amount about the distance of the predetermined end face of the aforementioned mask, and the 1st reflecting mirror of the above according to the aforementioned movement by the aforementioned 1st move mechanism (Imy, Ick, Ix1, Ix2), The 2nd interference system (Ipy, Ick, Ix1, Ix2) which detects the amount about the distance of the predetermined end face of the aforementioned sensitization substrate, and the 2nd reflecting mirror of the above according to the aforementioned movement by the aforementioned 1st move mechanism, It is the scanned type aligner characterized by establishing a storage means (26) to memorize the data about the flatness difference of the aforementioned reflector of the 1st reflecting mirror of the above, and the aforementioned reflector of the 2nd reflecting mirror of the above called for based on the detection result of the 1st interference system of

the above, and the 2nd interference system of the above.

[0004] While this invention projects the image of the pattern of a mask (5) on a sensitization substrate (6) by the projection optical system, again In the scanned type exposure method which is made to move the aforementioned mask and the aforementioned sensitization substrate in the 1st direction which synchronizes and intersects perpendicularly with the optical axis of the aforementioned projection optical system to the aforementioned projection optical system, and exposes the image of the pattern of the aforementioned mask The 1st reflecting mirror which has the predetermined end face of the aforementioned mask, and the reflector which counters, and was fixed along the 1st direction of the above (7), The 1st step which detects the amount about distance with the predetermined end face of the aforementioned mask according to the aforementioned movement, The 2nd reflecting mirror which has the predetermined end face of the aforementioned sensitization substrate, and the reflector which counters, and was fixed along the 1st direction of the above (8), The 2nd step which detects the amount about distance with the predetermined end face of the aforementioned sensitization substrate according to the aforementioned movement, It is the scanned type exposure method characterized by including the step which asks for the data about the flatness difference of the aforementioned reflector of the 1st reflecting mirror of the above, and the aforementioned reflector of the 2nd reflecting mirror of the above based on the above 1st and the detection result of the 2nd step.

[0005]

[Embodiments of the Invention] The gestalt of operation of this invention is explained using a drawing. The outline composition of one example of the scanned type aligner by this invention is shown in drawing 1 . In the following explanation, the system of coordinates which make a scanning direction, i.e., lengthwise, a x axis, make the y-axis the longitudinal direction which intersects perpendicularly in the same field as a mask 5 in a x axis, and make the direction of a normal of a mask 5 the z-axis are taken. The lighting light injected from the light sources (un-illustrating), such as an extra-high pressure mercury lamp, is led to 5 lighting optical system (un-illustrating) through an optical fiber (un-illustrating) etc. Each lighting optical system is constituted including a fly eye lens, a field diaphragm (un-illustrating), etc., respectively. Each lighting light injected from each lighting optical system illuminates uniformly the lighting fields 14a-14e where it differs on a mask 5. Each flux of light which passed the mask 5 exposes the exposure fields 15a-15e where it differs on the plate 6 which is a sensitization substrate through the projection optical system PL with the five projection lens sections which perform image formation of actual size erection, respectively (refer to drawing 9), and carries out image formation of the image of the pattern of the lighting fields 14a-14e on a mask 5 on a plate 6 in this way. Although each lighting fields 14a-14e are separated, respectively and it is arranged, the addition width of face which integrated the width of face of the x directions of each lighting fields 14a-14e in the x directions is formed so that it may continue in the direction of y with the same width of face.

[0006] Each lighting optical system and each projection optical system are supported with the stand 1. The carriage 2 by which a run drive is carried out is carried in the x directions by the driving gear (un-illustrating) at the stand 1, and the mask stage 3 and the plate stage 4 are held at this carriage 2. The mask 5 is held at the mask stage 3, the plate 6 is held on the plate stage 4, and the whole pattern on a mask 5 is imprinted on a plate 6 by scanning carriage 2 in the x directions in this way. The mask stage 3 is constituted so that it may be supported by carriage 2 through the jogging machines 9-11, namely, the position of the x directions of a mask stage 3 may be moved slightly with the x direction jogging machine 9 and the position of the direction of y of a mask stage 3 and the hand of cut of the

circumference of the z-axis can be moved slightly with the direction jogging machines 10 and 11 of y.

[0007] On the other hand, in order to amend the influence of the thickness nonuniformity of a plate 6, or an inclination and to make it simultaneously in agreement with the image formation side of a mask pattern, the plate stage 4 is supported by carriage 2 through the three or more direction jogging machines (un-illustrating) of z, and it is constituted so that jogging (auto-focusing) of the direction of z and the degree of tilt angle of the circumference of a x axis and the circumference of the y-axis (auto leveling) can be adjusted in this way. Moreover, the long mirror 7 for masks and the long mirror 8 for plates are being fixed to the stand 1. Both the long picture mirrors 7 and 8 are reflecting mirrors prolonged for a long time in the x directions, and the normal of the reflector has turned to the direction of y. The long mirror 7 for masks counters a mask stage 3, and is arranged, and the long mirror 8 for plates counters the plate stage 4, and is arranged.

[0008] Drawing 9 is the perspective diagram which expressed the scanned type aligner of drawing 1 partially. The projection optical system PL has the five projection lens sections arranged alternately in order to project the flux of light which passed through each field of the lighting fields 14a-14e on a plate 6. In addition, on behalf of the five projection lens sections, it expresses with drawing 9 the projection optical system PL, and the optical axis of a projection optical system PL is indicated to be AX. It is arranged along the direction of X the long mirror 7 for masks and whose long mirror 8 for plates are the 1st direction which intersects perpendicularly with the optical axis AX of a projection optical system PL so that clearly from drawing 9 .

[0009] It returns to drawing 1 and the position and posture of a mask stage 3 and the plate stage 4 are supervised as follows by six interferometers Ix1, Ix2, Icx, Imy, Ipy, and Ick. The differential type interferometer Ix1 is first for measuring a relative position gap (vertical gap) of the x directions of a mask stage 3 and the plate stage 4. Namely, the laser beam bunch injected from the laser light source (un-illustrating) fixed to the stand 1 It is divided by beam-splitter 16a fixed to the stand 1, and each divided flux of light Reflect with the reflecting mirrors 16b and 16d fixed to the stand 1, respectively, and it is fixed to a mask stage 3 and the plate stage 4, respectively, and reflects with reflecting mirrors 16c and 16e. It reverses, is compounded by beam-splitter 16a, and interferes in an outward trip, and incidence is carried out to the receiver (un-illustrating) of an interferometer Ix1.

[0010] An interferometer Ix1 is for measuring a relative position gap (vertical gap) of the x directions of a mask stage 3 and the plate stage 4 in the position where the differential type interferometers Ix2 differ in the direction of y. That is, the laser beam bunch for interferometer Ix2 is divided by beam-splitter 17a, and it reflects with reflecting mirrors 17b and 17d, respectively, is fixed to a mask stage 3 and the plate stage 4, respectively, and reflects with reflecting mirrors 17c and 17e, and each divided flux of light reverses, is compounded by beam-splitter 17a, and carries out incidence of the outward trip to the receiver of an interferometer Ix2. In addition, an interval with the reflecting mirrors 16c and 17c fixed to the mask stage 3 and the interval with the reflecting mirrors 16e and 17e fixed to the plate stage 4 are equal, and set this interval to H henceforth. As for the position of the reflecting mirrors 16c and 17c on a mask stage 3, and the reflecting mirrors 16e and 17e on the plate stage 4, it is desirable that it is in the equal distance from the center of each stages 3 and 4.

[0011] The measured type interferometer Icx of the length is for measuring the travel of carriage 2. The laser beam bunch for Interferometers Icx is divided by beam-splitter 18a, and namely, each divided flux of light Reflect with the reflecting mirrors 18b and 18d fixed to the stand 1, respectively, and one flux of light is reflected by reflecting mirror 18c fixed on the mask stage 3. Reflecting the flux of light of another side by fixed mirror 18e fixed to

the projection optical system, it reverses, is compounded by beam-splitter 18a, and interferes in an outward trip, and both the flux of lights carry out incidence to the receiver of Interferometer Icx. In this way, by Interferometer Icx, the distance of the x directions of a mask stage 3 and fixed mirror 18e is measured.

[0012] The measured type interferometer Imy of the length is for measuring the distance of the direction of y of a mask stage 3 and the long mirror 7 for masks. Moreover, the measured type interferometer Ipy of the length is for measuring the distance of the direction of y of the plate stage 4 and the long mirror 8 for plates. Since both the interferometers Imy and Ipy are the same composition, the explanation about Interferometer Imy is indicated out of a parenthesis, and the explanation about Interferometer Ipy is indicated in a parenthesis. That is, the laser beam bunch for interference systems Imy (Ipy) is divided into the two flux of lights by beam-splitter 19a (20a) fixed to the mask stage 3 (plate stage 4). this -- two -- a ** -- the flux of light -- inside -- a beam splitter -- 19 -- a (20a) -- having penetrated -- the flux of light -- a mask stage -- three (plate stage 4) -- a top -- arranging -- having had -- lambda -- /-- four -- a board -- 19 -- d (20d) -- a passage -- a mask stage -- three (plate stage 4) -- a top -- arranging -- having had -- a reflecting mirror -- 19 -- b (20b) -- reflecting -- again -- The flux of light which passed along 19d (20d) of lambda/4 boards Beam-splitter 19a (20a), Cube-corner-reflector 19c arranged on the mask stage 3 (plate stage 4) (20c), beam-splitter 19a (20a) -- respectively -- reflecting -- 19d (20d) of lambda/4 boards -- a passage -- reflecting mirror 19b (20b) -- reflecting -- 19d (20d) of lambda/4 boards, and beam-splitter 19a (20a) -- respectively -- a passage -- an interference system Imy (Ipy) -- incidence is carried out to a receiver

[0013] the flux of light reflected up by beam-splitter 19a (20a) of the flux of lights divided by beam-splitter 19a (20a) -- lambda / 4 board 19e (20e) -- a passage -- the long mirror 7 (8) -- reflecting -- lambda / 4 board 19e (20e), and beam-splitter 19a (20a) -- respectively -- a passage -- cube-corner-reflector 19c (20c) -- reflecting . the flux of light reflected by cube-corner-reflector 19c (20c) -- beam-splitter 19a (20a), and lambda/4 board 19e (20e) -- respectively -- a passage -- the long mirror 7 (8) -- reflecting -- lambda / 4 board 19e (20e) -- a passage -- beam-splitter 19a (20a) -- reflecting -- having -- an interference system Imy (Ipy) -- incidence is carried out to a receiver Thereby, the flux of light divided into the two flux of lights by beam-splitter 19a (20a) is again compounded by beam-splitter 19a (20a), and it interferes in it, and it carries out incidence to a receiver.

[0014] The differential type interferometer Ick is for measuring a relative position gap of the direction of y of a mask stage 3 and the plate stage 4 through both the long picture mirrors 7 and 8. That is, the laser beam bunch for Interferometers Ick is divided by beam-splitter 21a, each divided flux of light is reflected with the reflecting mirrors 21b and 21d fixed to the stand 1, respectively, it reflects by reflecting mirror 21c on a mask stage 3, and one flux of light is reflected in the long mirror 7 for masks. It reflects by reflecting mirror 21e on the plate stage 4, and the flux of light of another side is reflected in the long mirror 8 for plates. Both the flux of lights reverse, are compounded by beam-splitter 21a, interfere in an outward trip, and carry out incidence to the receiver of Interferometer Ick. In addition, the interval of the x directions of cube-corner-reflector 20c and reflecting mirror 21e which were fixed to the interval and the plate stage 4 of the x directions of cube-corner-reflector 19c and reflecting mirror 21c which were fixed to the mask stage 3 is equal, and sets this interval to L henceforth.

[0015] The position of carriage 2 is set to x, the relative amount of position gaps of the x directions of a mask stage 3 and the plate stage 4 (the amount of vertical gaps) is set to deltaX (x), the relative amount of position gaps of the direction of y (the amount of strike slips) is set to deltaY (x), and the relative amount of angle gaps of the circumference of the z-axis is set to deltaT (x). Moreover, the flatness difference of both the long picture mirrors

7 and 8 is set to deltah (x). Flatness difference deltah is the relative amount of position gaps of the direction of y of the reflector of the long mirror 7 for masks, and the reflector of the long mirror 8 for plates (the amount of strike slips). When the measurement value of each interferometers Ix1, Ix2, Icx, Imy, Ipy, and Ick is expressed as Ix1, Ix2, Icx, Imy, Ipy, and Ick using the respectively same character, it is deltaX(x) = (Ix1+Ix2)/2. .... (1)
deltaT (x) =(Ix1-Ix2)/H .... (2)
deltaY (x) =Imy-Ipy-deltah (x) .... (3)
It becomes.
[0016] The value of angle gap deltaT of vertical gap deltaX of (1) formula and (2) formulas is immediately acquired from the measurement value of interferometers Ix1 and Ix2 among the above-mentioned (1) - (3) formulas. Moreover, about strike slip deltaY of (3) formulas, flatness difference deltah is stored in the storage 26 in a control unit 25 as a function of the position x of carriage 2, and strike slip deltaY is calculated from this deltah (x) and measurement value of Interferometers Imy and Ipy. In this way, the relative physical relationship of the mask stage 3 at the time of scanning exposure and the plate stage 4 is kept constant by driving the jogging machines 9-11 and tuning the position of a mask stage 3 finely in a x-y side with a control unit 25, to vertical gap deltaX in a x-y side, strike slip deltaY, and angle gap deltaT.
[0017] How to ask below for flatness difference delta[of both the long picture mirrors 7 and 8] h (x) is explained. This flatness difference deltah (x) is dependent on the installation posture to the mirror-plane configuration of each long mirror 7 and 8 the very thing, and the stand 1 of each long mirrors 7 and 8. this example measures continuously the mirror-plane configuration of each long mirror 7 and 8 the very thing in one side. By measuring dispersedly flatness difference delta[when attaching each long mirrors 7 and 8 in a stand 1 in another side] h (x), and interpolating the inside of each section of flatness difference deltah for which after an appropriate time was asked dispersedly with the difference of the continuous configuration of both the long picture mirrors 7 and 8 It asks for flatness difference deltah as a continuous function of x.
[0018] Then, how to search for continuously the mirror-plane configuration of each long mirror 7 and 8 the very thing is explained first. Drawing 2 is drawing having shown the outline for measuring continuously the profile irregularity of each long mirrors 7 and 8. It is efficient to perform this measurement to serve both as a check and measurement of profile irregularity at the time of the polish end of the long mirrors 7 and 8 before the inclusion to a stand 1. Moreover, as for the posture of the long mirrors 7 and 8 at the time of measurement, it is desirable to suppose that it is the same as that of the posture when including in a stand 1.
[0019] The laser beam bunch injected from the laser light source 30 can extend **** with the beam expander 31, and serves as a parallel ray through a lens 32. Subsequently, a laser beam penetrates a one-way mirror 33, it reflects in respect of [35] the reference prepared in the last side of the Fizeau element, and a part of transmitted light reverses an outward trip, and it returns to a one-way mirror 33. The rear face 34 of the reference side 35 is coated with the antireflection film. On the other hand, it reflects in the long mirror 7 (or long mirror 8 for plates) for masks, and the laser beam which penetrated the reference side 35 reverses an outward trip, and returns to a one-way mirror 33. It interferes, and reflects by the one-way mirror 33, and the laser beam reflected in respect of [35] reference and the laser beam reflected in the long mirror 7 (8) reach a detector 36. In this way, it becomes possible to be able to measure the profile irregularity of the long mirror 7 (8) to the reference side 35 with a detector 36, namely, to ask for the flatness in the arbitrary points of the long mirror 7 (8).
[0020] In addition, although, as for the long mirror 7 (8), a bird clapper is expected for a

long time with enlargement of a liquid crystal substrate, when it becomes longer than the reference side 35, the whole surface can be measured by shifting the long mirror 7 (8) and measuring multiple times. However, it is necessary to make the measure point by the interferometers Imy, Ipy, and Ick later mentioned in this case overlap, and to measure. Moreover, although the Fizeau interferometer was used for measurement of the profile irregularity of the long mirror 7 (8) in drawing 2 , the measurement method was not restricted to this.

[0021] Next, how to measure the flatness difference of a long mirror dispersedly is explained. Measurement is measured at every fixed measurement interval L, scanning carriage 2. A measurement end fixes a mask stage 3 and the plate stage 4 relatively, namely, the jogging machines 9-11 do not drive it. Let the interval L which measures be the interval of the x directions of the position which the flux of light of Interferometer Imy or Interferometer Ipy reflects in the long mirror 7 or the long mirror 8, and the position which the flux of light of Interferometer Ick reflects in the long mirror 7 or the long mirror 8. Measurement is performed as follows. The value of the interferometers Imy, Ipy, and Ick when moving carriage 2 to the end of the long mirrors 7 and 8 is measured. Subsequently, measuring the position of carriage 2 with Interferometer Icx, only L moves the position of carriage 2 and the value of Interferometers Imy, Ipy, and Ick is measured in the position. Like the following, whenever only L moves the position of carriage 2, the value of Interferometers Imy, Ipy, and Ick is measured.

[0022] Below, since it is easy, the measurement value of the interferometers Imy, Ipy, and Ick in the dispersed measurement position i on a long mirror is marked as Imy (i), Ipy (i), and Ick (i), respectively. That is, when a dispersed position is meant, Variable i is used, and Variable x is used when a continuous position is meant. In addition, in the position of the same carriage 2, Imy (i), Ipy (i), and Ick (i-1) are measured clearly. Moreover, the value of the interferometer in a measurement starting position is set to Imy (1), Ipy (1), and Ick (0).

[0023] Interferometer Imy is measuring the distance of the direction of y of a mask stage 3 and the long mirror 7 for masks, and Interferometer Ipy is measuring the distance of the direction of y of the plate stage 4 and the long mirror 8 for plates. Therefore, the rolling error (rotation of the circumference of a x axis) of carriage 2 and the offset at the time of interferometer reset are included in the measurement value of both these interferometers Imy and Ipy in addition to flatness difference deltah of both the long picture mirrors 7 and 8. The flatness difference of both the long picture mirror in the measurement position i is set to deltah (i), the amount of rolling is set to r (i), and the offset at the time of reset of both the interferometers Imy and Ipy is set to A and B, respectively.

[0024] It is newly Iy(i) **Imy(i)-Ipy about Iy (i) as a difference of the measurement value of both the interferometers Imy and Ipy (i). .... (4)

A definition materializes the following formula.

Iy(i) **Imy(i)-Ipy (i)

= deltah(i)+r(i)+A-B .... (5)

(5) Among a formula, Iy (i) is measured value and the right-hand side's is strange.

[0025] Moreover, Interferometer Ick is measuring the position gap of the direction of y of a mask stage 3 and the plate stage 4 through both the long picture mirrors 7 and 8. Therefore, the position gap resulting from vertical gap deltaX of a mask stage 3 and the plate stage 4 and angle gap deltaT of the circumference of the z-axis other than the offset C at the time of the error r resulting from flatness difference deltah of both the long picture mirrors 7 and 8 and rolling of carriage 2 and interferometer reset is further included in the measurement value of Interferometer Ick. Moreover, the amount of rolling contained in the measurement value of the interferometers Imy, Ipy, and Ick measured simultaneously is equal. Therefore, Ick (i-1) is expressed with the following formula.

Ick(i-1) =deltah(i-1) +r (i) +C +deltaX(i-1) +deltaT(i-1) -H .... (6)

[0026] Since vertical gap deltaX and angle gap deltaT are measured value, if they define Ick' by (7) formulas, (6) formulas will turn into (8) formulas.

Ick'(i) ** -- Ick(i)-deltaX(i)-deltaT(i) -H .... (7)

Ick'(i-1) =deltah(i-1) +r (i) +C .... (8)

(8) Among a formula, Ick' (i-1) is measured value, and the right-hand side's is strange.

[0027] Furthermore, if (9) formulas define deltaH in order to eliminate the error r resulting from rolling of carriage 2, deltaH will become like (5) formulas and (8) formulas to (10) formulas.

deltaH(i) **Iy(i)-Ick' (i-1) .... (9)

deltaH(i) =deltah(i)-deltah(i-1)+A-B-C .... (10)

(10) Among a formula, deltaH (i) is calculated from the measurement value of interferometers Imy, Ipy, Ick, Ix1, and Ix2, and the right-hand side's is strange.

[0028] If the sum from i= 1 to i=k (k>=1) of deltaH (i) is set to S (k) and the position k of a long mirror is newly marked as a position i S(i) **deltaH(1)+deltaH [.. (11a)] (2) + ... +deltaH (i)

S(i) =deltah(1)-deltah(0)+A-B-C + deltah(2)-deltah(1)+A-B-C + ... + +deltah(i)-deltah(i-1)+A-B-C =deltah(i)-deltah (0) +(A-B-C) xi (i>=1)

.... (11b)

It becomes. (11b) Among a formula, S (i) is measured value and the right-hand side's is strange. flatness difference delta[of a long mirror / in / a position i / in this way (11b) / from a formula] / h (i) delta -- h(i) =S(i)+deltah(0)-(A-B-C) xi (i>=1)

.... (12)

It becomes. If it sets with S(0) **0 at the time of i= 0, (12) formulas will be realized also at the time of i= 0.

[0029] (12) Among the right-hand side of a formula, S (i) is measured value and deltah (0) and x(A-B-C) i are unknowns. Among these, since deltah (0) is always fixed offset irrespective of the measurement position i of a long mirror, it does not become an error by amount of strike slips delta[between a mask stage 3 and the plate stage 4] Y's (x)'s not changing, namely, carrying out alignment of a mask stage 3 and the plate stage 4 so that more clearly than (3) formulas. On the other hand, since x(A-B-C) i changes to alignment depending on the position i of a long mirror, it needs to ask for the coefficient (A-B-C). Then, how to ask for a coefficient (A-B-C) next is shown.

[0030] First, as the 1st process, in order to measure S in (12) formulas (i), carriage 2 is scanned and the measurement value of each interferometer is measured. At this time, amount of vertical gaps deltaX between a mask stage 3 and the plate stage 4 is continuously measured by (1) formula like previous statement, and amount of angle gaps deltaT in a x-y side can scan carriage 2, keeping constant these amounts delta X and delta T of gaps, since it is continuously measured by (2) formulas. However, flatness difference deltah (x) is not only strange, but since discrete-value deltah (i) is strange, amount of strike slips deltaY cannot keep amount of strike slips deltaY constant. Then, first, carriage 2 is scanned without performing adjustment of a strike slip at all, and x= 0 at that time, L, 2xL, ..., ixL, the measurement value Imy of Interferometers Imy and Ipy in .. (i), and Ipy (i) are measured. Subsequently, as the 2nd process, it asks for S (i) by the formula (11a).

[0031] Subsequently, as the 3rd process, in order to calculate (A-B-C) in (12) formulas, the mask 40 for error measurement shown in <u>drawing 3</u> is set to a mask stage 3, the plate for error measurement is set to the plate stage 4, and 1st scanning exposure is performed. However, although S in (12) formulas (i) became known, since the coefficient (A-B-C) is strange, it disregards this coefficient (A-B-C), namely, it is deltah(i) =S as a provisional formula of the flatness difference of both the long picture mirror (i). .... (13)

********. Moreover, since i is a discrete value, it interpolates between deltah (i) and deltah (i+1) by the primary formula. That is, the relation between the measurement position i and the position x of the carriage 2 measured with Interferometer Icx is expressed with the following formula when the value of the interferometer Icx in a measurement starting position is set to 0.

x=ixL .... (14)

[0032] Therefore, provisional formula delta[of the flatness difference of both the long picture mirror in case carriage 2 is between the measurement position i on a long mirror and i+1] h (x) is expressed with the following formula.

deltah(x) = [deltah(i+1)-deltah (i)] x (x/L-i)
+ deltah (i) .... (15)

Carriage 2 is scanned asking for amount of strike slips deltaY between a mask stage 3 and the plate stage 4, and keeping constant this amount of strike slips deltaY by (3) formulas, since the estimate of the flatness difference of both the long picture mirror is continuously obtained by (13) formulas and (15) formulas in this way.

[0033] Drawing 3 shows the mask 40 for error measurement, and two or more marks 41 are drawn by this mask 40 in the x directions at one train, and are drawn in the direction of y again at every interval L. As for the interval of the direction of y of a mark 41, it is desirable to make it in agreement with the measurement interval L in dispersed flatness measurement of both the long picture mirror. Drawing 4 shows the enlarged view of one mark 41, and is a pattern for exposure position detection. In this drawing, the slash section is a shading field and a cross-like portion is a light transmission field. Although the cross hair was used for exposure position detection here, what mark may be used as long as it is the mark which can detect an exposure position. Moreover, the alignment marks 42 and 43 for masks of a couple and the alignment marks 44 and 45 for plates of a couple are drawn by the mask 40 for error detection. both the marks 42 and 43; -- it shifts a little to the both sides of x directions and the direction of y, and 44 and 45 are arranged to them, as shown in drawing 3

[0034] A plate is developed after scanning exposure of a mask 40. As shown in a plate 48 at drawing 5 , the imprint mark (un-illustrating) of the alignment marks 42 and 43 for masks and the imprint marks 46 and 47 of the alignment marks 44 and 45 for plates other than the imprint mark 49 of two or more marks 41 are imprinted. Subsequently, both a mask 40 and a plate are rotated 90 degrees, it sets to a mask stage 3 and the plate stage 4, respectively, and alignment of the alignment marks 42 and 43 for masks on a mask 40 and the alignment mark imprint marks 46 and 47 for plates on a plate 48 is performed. namely, both the marks 42 and 43; -- the relative position error of 46 and 47 -- the alignment microscopes 12 and 13 -- measuring -- the mark motives 9-11 -- driving -- both the marks 42 and 43; -- the position of 46 and 47 is doubled and 2nd exposure is performed after an appropriate time

[0035] It shifts in the alignment marks 42 and 43 for masks on a mask 40, the alignment marks 44 and 45x for plates, and the direction of y a little, and is arranged, and alignment of the alignment marks 42 and 43 for masks and the imprint mark of the alignment mark for plates was carried out at the time of the 2nd exposure. Therefore, between the 1st exposure and the 2nd exposure, it means that only the interval of the alignment marks 42 and 43 for masks and the alignment marks 44 and 45 for plates had shifted and exposed the mask 40 and the plate 48.

[0036] Consequently, the image 49 of two or more marks 41 obtained by two exposure turns into an image with two cross hairs, as shown in drawing 6 . The amount of gaps of the net between both cross hairs can be known by measuring the interval of both cross hairs under a microscope etc., and deducting the amount of position gaps of a mask 40 and a

plate 48 from this measured value. Control of the jogging machines 9-11 is correctly controlled in the x directions, and is controlled by the provisional formula in the direction of y here. Therefore, between a mark 41 and its image, there is no gap in the x directions and only the error by having controlled by the provisional formula produces a position gap in the direction of y. Namely, in the 1st exposure, since there is no gap between a mark 41 and its image in the x directions and it was rotating 90 degrees at the time of the 2nd exposure, speaking of the arrangement at the time of the 2nd exposure, there is no gap between a mark 41 and its 1st image in the direction of y. Moreover, between a mark 41 and its 2nd image, only the error by having controlled by the provisional formula in the direction of y produces a position gap about the arrangement at the time of the 2nd exposure. Therefore, by measuring the amount of gaps of the net of the direction of y between both cross hairs, the error by having controlled by the provisional formula can be known.
[0037] Subsequently, it asks for a coefficient (A-B-C) as the 4th process. Drawing 7 is drawing which took the position i of a mark 41 along the horizontal axis, and plotted the amount of position gaps of the net of the direction of y, i.e., a longitudinal direction, on the vertical axis. The amount of position gaps of lateral net is -deltah(0)+(A-B-C) xi. .... (16) Since it becomes, if it asks for a regression line 50 from the point which drawing 7 plotted, the inclination will serve as a coefficient (A-B-C). It can ask for dispersed flatness difference deltah (i) of both the long picture mirror from (12) formulas in this way.
[0038] In addition, in each measure point where control of the jogging machine in the 3rd process measured S (i), the right control is performed except for the point that x(A-B-C) i is disregarded. Therefore, as for the measure point which measures the net amount of strike slips, it is desirable to make it in agreement with the measure point when asking for S (i). It is because there is a possibility that elements other than x(A-B-C) i may be added when the net amount of strike slips is measured points other than the measure point when asking for S (i). In order to make in agreement the measure point which measures the net amount of strike slips, and the measure point when asking for S (i), it is necessary to make the interval of a mark 41 first in agreement with the measurement interval L when asking for S (i). Subsequently, what is necessary is to set a mask 40 by arrangement of the 2nd exposure, and just to let the place which moved carriage by the integral multiple of L be a criteria position from the place whose mark 41 on a mask 40 corresponds with an exposure position, in case you decide the criteria position of the scanning direction of carriage 2, in order to make the measure point itself in agreement. In addition, naturally you may reverse the sequence of the 1st exposure and the 2nd exposure.
[0039] Moreover, when the measure point which measures the net amount of strike slips in this way, and the measure point when asking for S (i) are made in agreement, especially control of the jogging machine in the mid-position of each measure point does not pose a problem. Therefore, although between each measure point was only interpolated to alignment in this example, between each measure point can also be interpolated according to the actual flatness difference of both the long picture mirror, for example. Thus, the technique of interpolating between each measure point according to the actual flatness difference of both the long picture mirror is effective when it is difficult to make in agreement the measure point which measures the net amount of strike slips, and the measure point when asking for S (i).
[0040] Moreover, by two exposure, it can replace with the method of measuring a position gap of the direction of y dispersedly, and a position gap of the direction of y can also be measured dispersedly as follows, without exposing. That is, as it is indicated in (b) as drawing 8 (a), to the mask [for error measurement] 60, and end side of the direction of y of a plate 61, two or more alignment marks 62 and alignment marks 63 are arranged in the

x directions at intervals of L, respectively, and alignment mark 62b and alignment mark 63b are arranged at the other end side of the direction of y, respectively. Positioning of a mask 60 and a plate 61 is performed by setting this mask 60 and plate 61 to a mask stage and a plate stage, respectively, carrying out alignment of one alignment mark 62a of two or more alignment marks 62 on a mask 60, and the one alignment mark 63a of two or more alignment marks 63 on a plate 61, and carrying out alignment of alignment mark 62b on a mask 60, and the alignment mark 63b on a plate 61.

[0041] Subsequently, amount of vertical gaps deltaX is correctly controlled by (1) formula, amount of angle gaps deltaT in a x-y side is correctly controlled by (2) formulas, and amount of strike slips deltaY scans carriage 2, controlling by (3) formulas using the provisional formula of the flatness difference of both the long picture mirror obtained by (13) formulas and (15) formulas. And the error of the direction of y of two or more alignment marks 62 on a mask 60 and two or more alignment marks 63 on a plate 61 is measured using the alignment microscope 12. A measurement end does not amend the error measured under the alignment microscope 12 in that case. If the position of the alignment marks 62 and 63 is taken along a horizontal axis and the measurement error of the direction of y is plotted on a vertical axis after an appropriate time, since the same result as drawing 7 is obtained, it can ask for dispersed flatness difference deltah (i) of both the long picture mirror.

[0042] Next, it asks for flatness difference delta[of the long mirror in arbitrary positions] h (x) by compounding the mirror-plane configuration of each long mirror 7 and 8 the very thing measured with dispersed flatness difference deltah (i) and the interferometer of both the long picture mirror as the 5th process. When flatness of the mask side long picture mirror 7 measured with the interferometer is set to km (x) and flatness of the plate side long picture mirror 8 is set to kp (x), flatness difference delta[of both the long picture mirror in the posture measured with the interferometer] k (x) is deltak(x) =km(x)-kp (x).
It becomes.

[0043] Composition with flatness difference delta[of both the long picture mirror in the posture measured with dispersed flatness difference deltah (i) and the interferometer of both the long picture mirror] k (x) each section [-- it carries out by moving deltak (x) in the direction of y, and expanding or reducing in the direction of y so that deltak (x) may be divided into every i and i+1] and it may be in agreement with deltah (i) and deltah (i+1) at the ends of the section namely, -- if movement magnitude added to deltak (x) for every section is set to sft (i) and the inclination added for every section is set to mag (i) delta --
h(i) =deltak(x)+sft(i)+mag(i) x (x-ixL)
[ixL<=x<=(i+1) xL] .... (17)
It becomes.

[0044] In x=ixL deltah(i) =deltak(ixL)+sft (i) .... (18)
coming out -- it is -- x=(i+1) xL -- setting -- delta -- h(i+1) =deltak(i+1) (xL)+sft(i)+mag(i) xL .... (19)
Since come out and it is sft(i) =deltah(i)-deltak (ixL) .... (20)
mag(i) =[deltah(i+1)-deltak (i+1) (xL)
- DeltaH (I) +DeltaK(IxL)]/L .... (21)
It becomes.

[0045] therefore, continuous flatness difference deltah (x) of the long mirror in section ixL<=x<=(i+1) xL delta -- h(x) =deltak(x)+sft(i)+mag(i) x (x-ixL)
.... (22)
It becomes. However, sft (i) and mag (i) are given by (20) and (21) formulas, respectively. Furthermore, if sft (i) and mag (i) are calculated by the entire interval, it can ask for continuous flatness difference deltah (x) in arbitrary positions.

[0046] In addition, the interval L of cube-corner-reflector 19c and reflecting mirror 21c which were fixed to the mask stage 3 or when the interval L of cube-corner-reflector 20c and reflecting mirror 21e which were fixed to the plate stage 4 is narrowed fairly Between dispersed flatness difference deltah (i) and deltah (i+1) of a long mirror which adjoin mutually can also be interpolated to alignment, without measuring continuously the configuration of both the long picture mirror 7 and 8 the very thing. Moreover, when the continuous flatness of a long mirror divides and is measured by enlargement of a long mirror, as for deltak used in the section [ixL<=x<=(i+1) xL] of (22) formulas (x), i.e., km, (x), and kp (x), what was obtained by the same measurement is desirable.

DESCRIPTION OF DRAWINGS

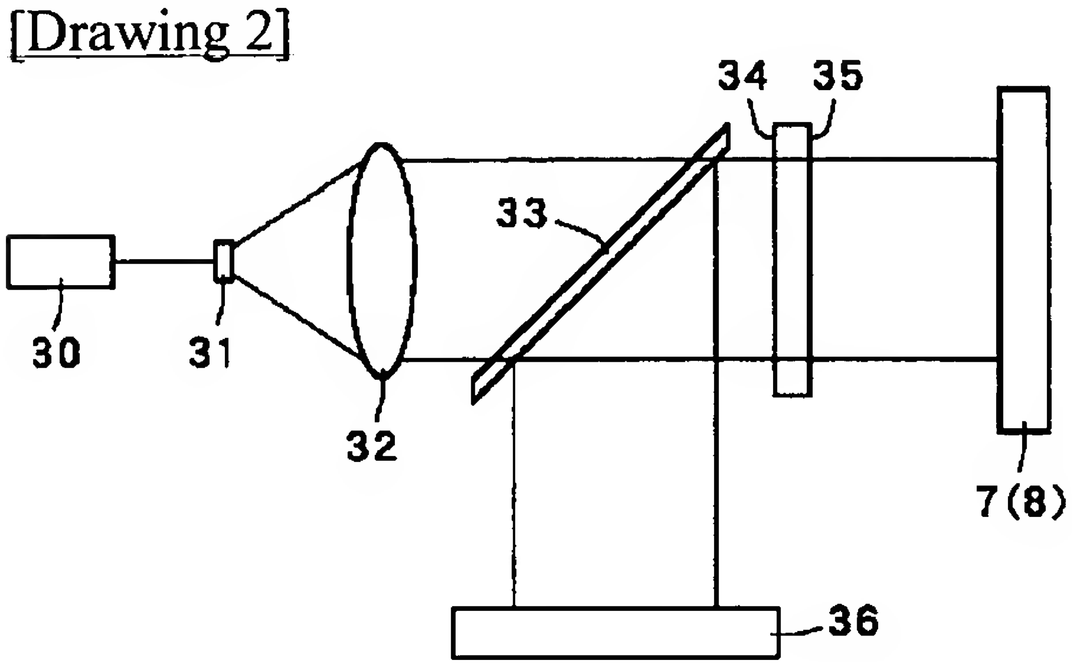
[Brief Description of the Drawings]
[Drawing 1] The perspective diagram showing the composition of one example of the scanned type aligner by this invention
[Drawing 2] The plot plan when measuring the profile irregularity of a long mirror continuously
[Drawing 3] The plan showing the mask used in order to measure the error produced by the provisional formula
[Drawing 4] The enlarged view showing the mark used for the mask for error measurement
[Drawing 5] The plan showing the plate with which the mark of the mask for error measurement was imprinted
[Drawing 6] The enlarged view showing the image of the mark imprinted by two exposure
[Drawing 7] Explanatory drawing showing the exposure distribution of errors
[Drawing 8] The plan showing another (a) mask used in order to measure the error produced by the provisional formula, and the (b) plate
[Drawing 9] It is the perspective diagram which expressed the scanned type aligner of drawing 1 partially.
[Brief Description of Notations]
1 -- Stand 2 -- Carriage
3 -- Mask stage 4 -- Plate stage
5 -- Mask 6 -- Plate
7 -- Long mirror for masks 8 -- Long mirror for plates
9, 10, 11 -- Mark motive 12 13 -- Alignment microscope
14a-14e -- Mask lighting field 15a - 15e plate exposure field
Ix1, Ix2, Icx, Imy, Ipy, Ick -- Interferometer
16a, 17a, 18a, 19a, 20a, 21a -- Beam splitter
16b-16e, 17b-17e, 18b-18e -- Reflecting mirror
19b, 20b, 21b-21e -- Reflecting mirror
19c, 20c -- Cube corner reflector
19d, 19e, 20d, 20 e--lambda / 4 board
25 -- Control unit 26 -- Storage
30 -- Laser light source 31 -- Beam expander
32 -- Lens 33 -- One-way mirror
34 -- Rear face 35 -- Reference side
36 -- Detector
40 -- Mask for error measurement 41 -- Mark
42 43 -- Alignment mark for masks
44 45 -- Alignment mark for plates
46 47 -- Alignment mark imprint mark for plates

48 -- Plate for error measurement 49 -- Mark imprint mark
50 -- Regression line
60 -- Mask for error measurement 61 -- Plate for error measurement
62 63 -- Alignment mark

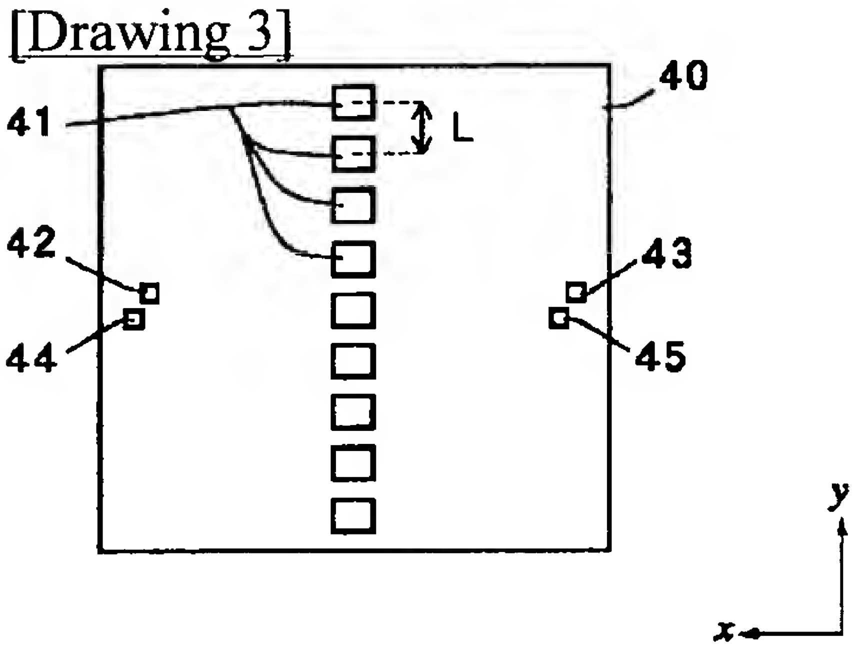
DRAWINGS

DRAWINGS

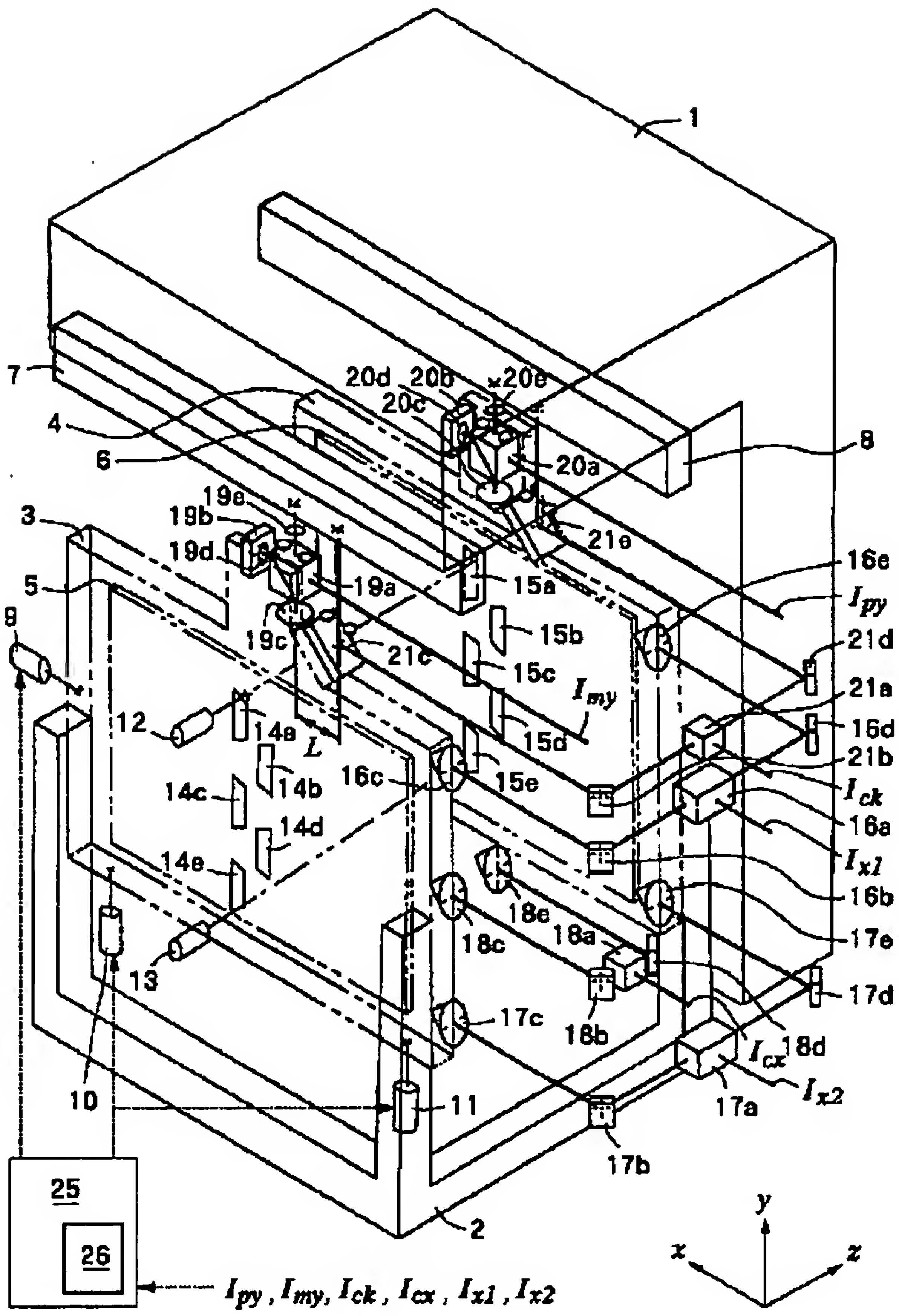
[Drawing 2]



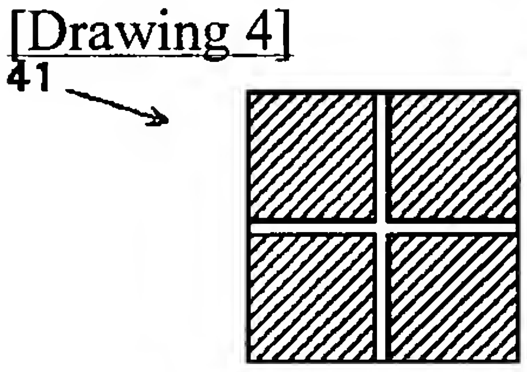
[Drawing 3]



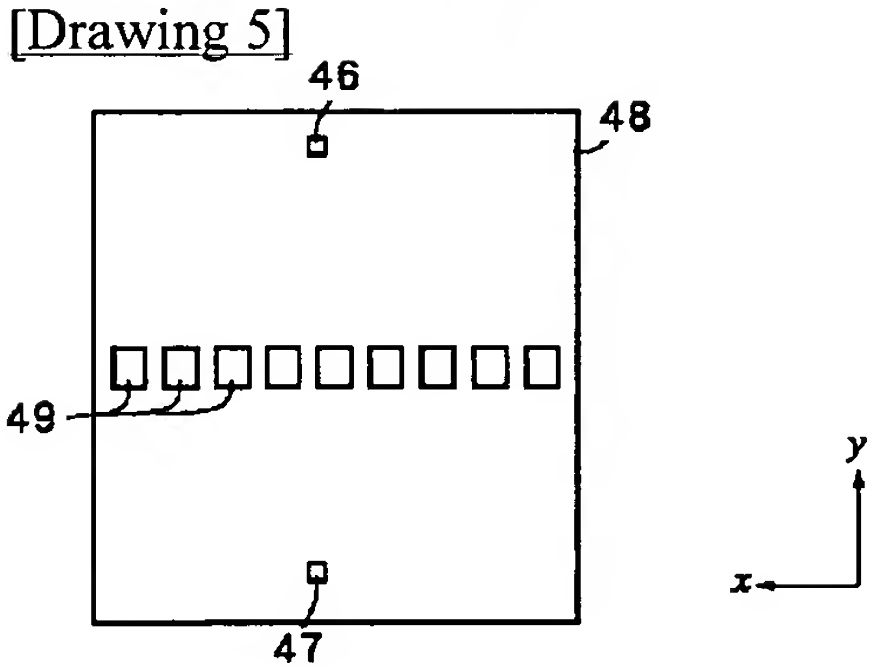
[Drawing 1]



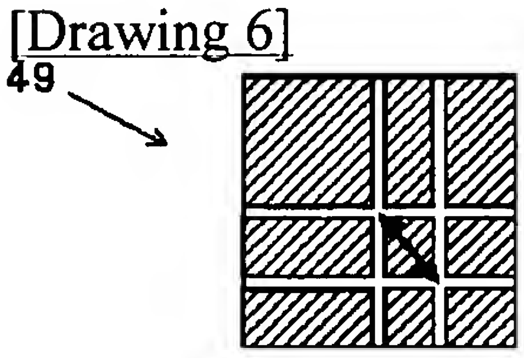
[Drawing 4]



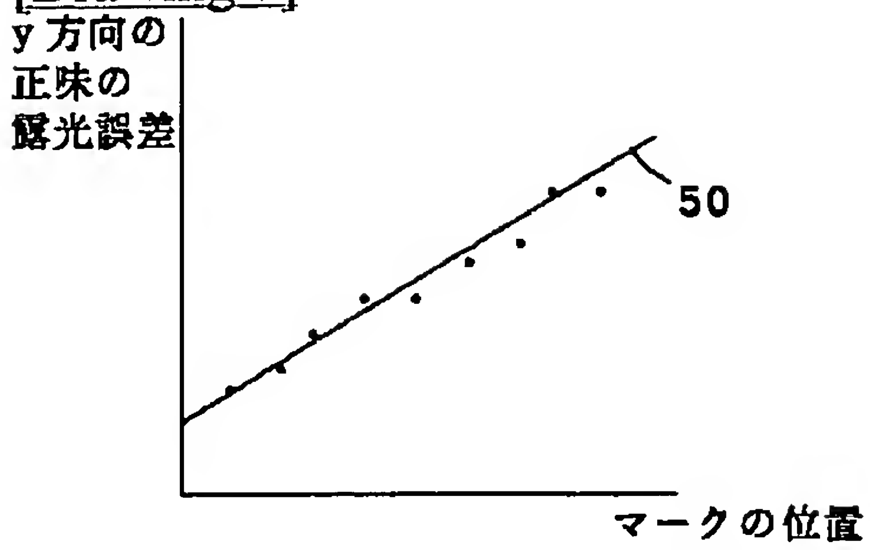
[Drawing 5]



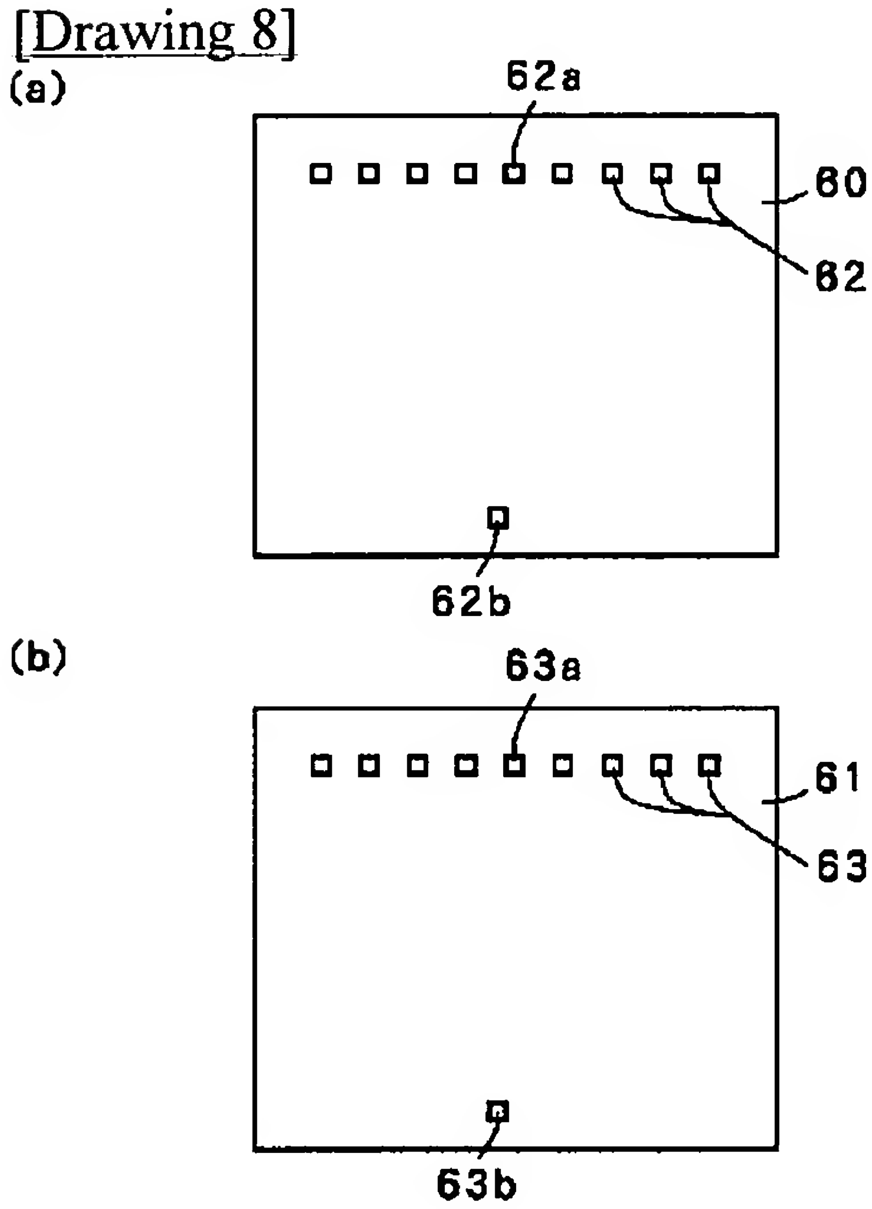
[Drawing 6]



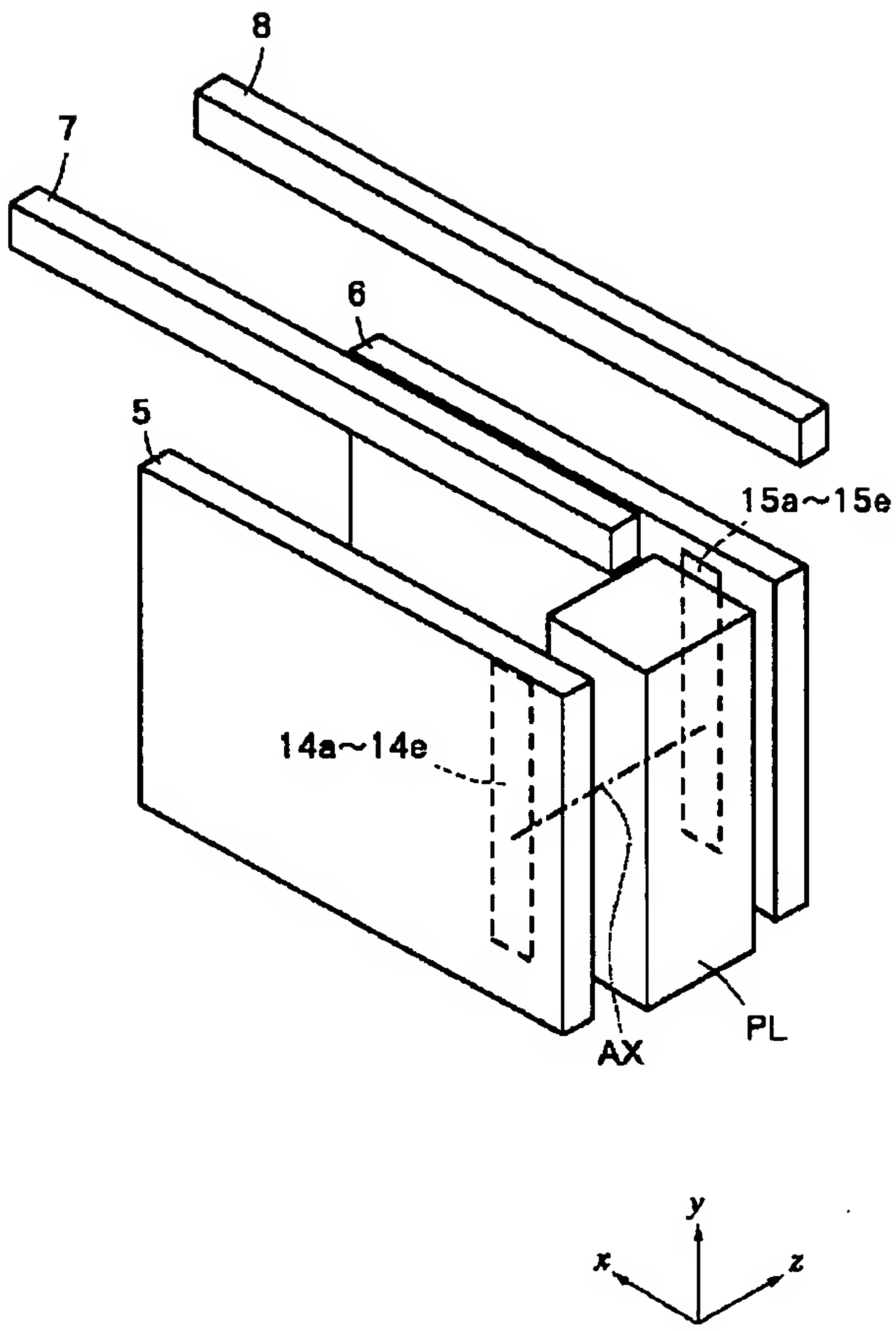
[Drawing 7]



[Drawing 8]



[Drawing 9]



[Translation done.]